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ABSTRACT

This guide provides a basic program for managers and supervisors responsible for the care of buildings, grounds, and equipment; provides the maintenance staff member with basic information and solutions to typical problems; and is intended to be used as a training tool and a reference source. The manual is divided into five categories. (1) "Basics of Good School Maintenance" covers management concepts, energy conservation, safety, and building design. (2) "General Building Maintenance" provides basic methods for organizing and carrying out procedures for routine cleaning and external building care. (3) "Grounds Maintenance" offers management programs and step-by-step procedures for the care of trees, shrubs, lawns, and asphalt surfaces. (4) "Mechanical Equipment" covers routing maintenance and repair procedures for heating and air conditioning systems (from boilers to temperature controls), sanitary systems and fixtures, sewage treatment plants, electrical systems, and food service equipment. (5) "Management Tools Appendix" provides ready-to-use forms for work assignments, record keeping, work evaluations, and physical plant inspections. (Author/MLF)

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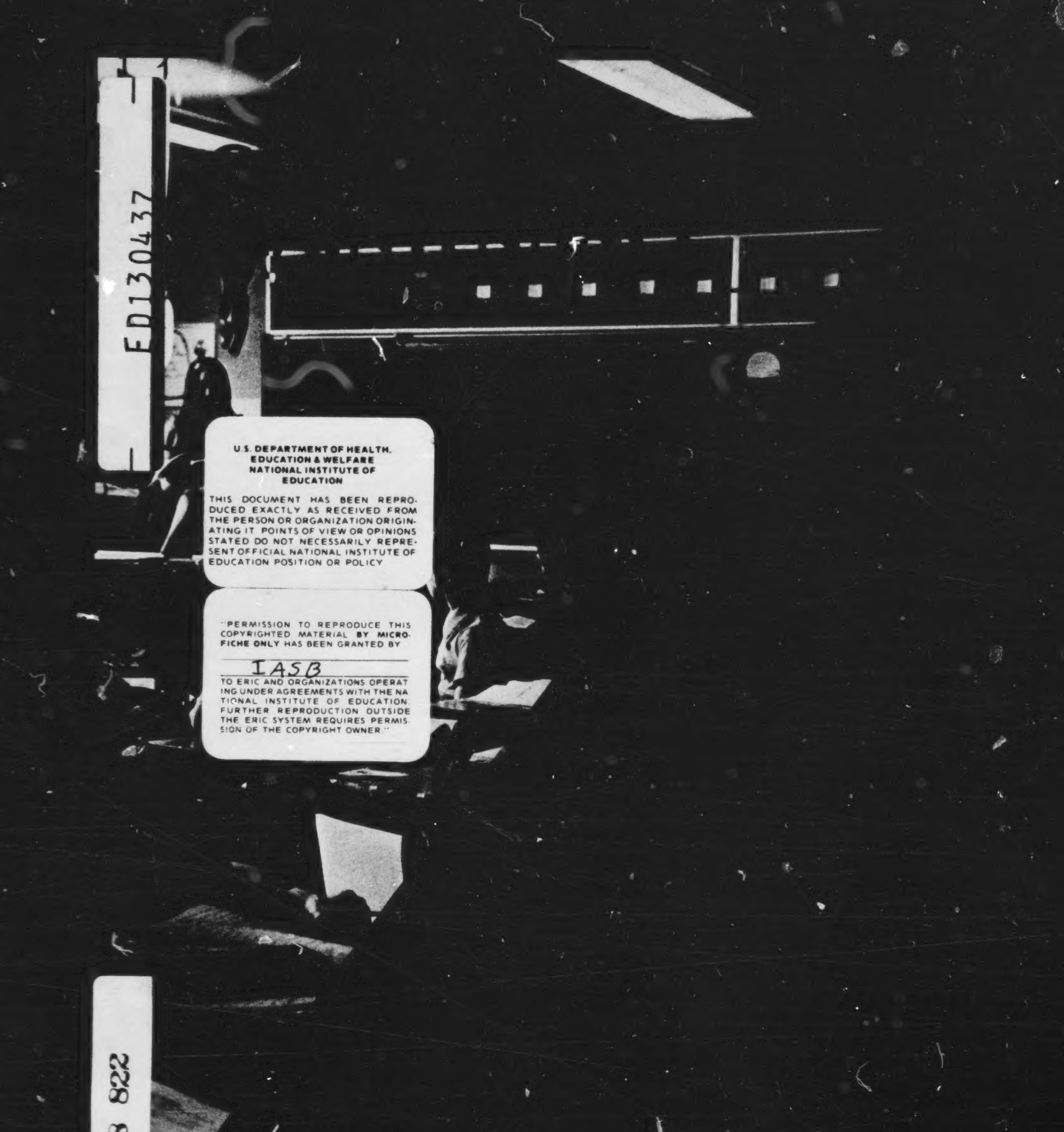

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a manual of programs and procedures for buildings • grounds • equipment

SERVICE ASSOCIATES • ILLINOIS ASSOCIATION OF SCHOOL BOARDS
SENIOR EDITOR JACK T. HARROUN

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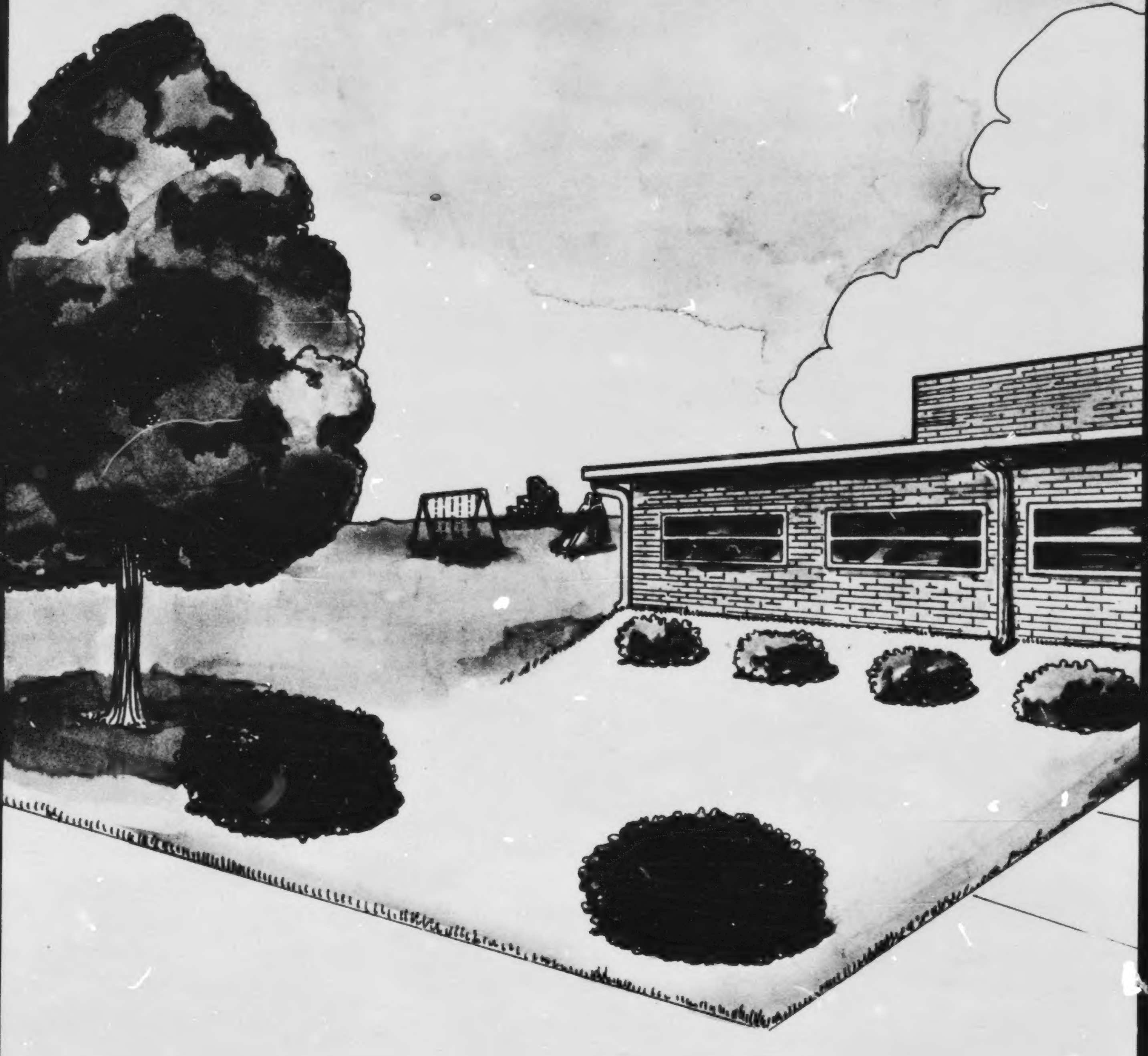

Good School Maintenance Manual
Committee Members
of the
Illinois Association of School Boards
Service Associates

The following individuals served on the committee which planned and developed this Manual over a period of nearly three years.

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GOOD SCHOOL MAINTENANCE

a manual of programs and procedures for
buildings • grounds • equipment

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A word about *Good School Maintenance*

School officials often do not appreciate the importance of preventive maintenance programs. Although school boards are responsible for millions of dollars in physical plant and equipment, they may not be aware that extra effort toward maintenance can result in significant long-run savings.

A school building is more than a physical plant that must be protected. It is an environment where learning is supposed to take place. How well the maintenance team does its job has a large part in determining the suitability of that environment.

PURPOSE OF THIS MANUAL

A major aim of the IASB Service Associates is to call attention to the need for sensible maintenance planning. A second aim is to provide any help that school officials may need in implementing maintenance programs. These two purposes led to the development of the *Good School Maintenance* Manual.

The Manual itself is designed to fill two distinct needs in the school maintenance field:

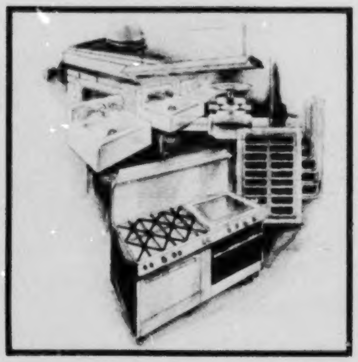
1) The Manual is intended as a basic training tool. It can be used as a text or resource in training new maintenance staff members. Members of the maintenance staff can use it to refresh their knowledge — in effect, to train themselves. The Manual is probably best viewed as one tool in a larger, continuing program of staff development.

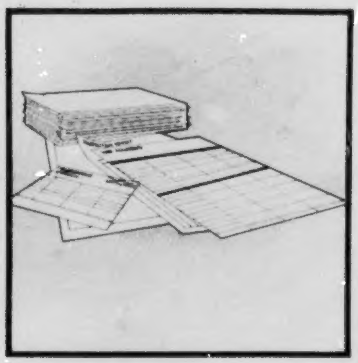
2) The Manual also is intended as a reference source. It covers most routine tasks and problems encountered in school sanitation and maintenance. The maintenance staff member who is stumped for an answer may well find it in this Manual.

As a training tool, this Manual should prove useful to the maintenance manager as well as to the staff trainee. As a reference source, both should find it equally helpful.

TWELVE YEARS IN THE MAKING

The beginning of *Good School Maintenance* dates back some 12 years, to 1964 when IASB Service Associates published the first section to the





Planned Maintenance Manual. Over the years, the latter manual – published in a ring binder – grew in size and complexity. It was finally decided in 1973 to begin from scratch – to totally re-evaluate, re-plan and republish the manual in book form.

Material for the original *Planned Maintenance Manual* was written by subject matter specialists affiliated with Service Associate firms. Many of these same authors and some of their original material appear in this new Manual. All of it, however, has been carefully up-dated, and revised for greater continuity, readability, and utility. Attention in *Good School Maintenance* focuses on the kinds of problems that most school maintenance teams confront. The rare or unusual has been deleted.

ROLE OF SERVICE ASSOCIATES

The *Good School Maintenance* Manual is made possible by the Service Associates of the Illinois Association of School Boards. Service Associates consist of firms which do business with schools and which are invited to become members based upon their reputations for honesty and integrity. The member firms each appoint an individual to work with IASB in governing the Service Associates and carrying out its programs. (Service Associate programs range from workshops and publications to the practical interpretation of standards and proposed standards.)

Service Associate firms donated untold manhours to the development of this Manual. Those who contributed material are listed on page 8. Those individuals who served on the Maintenance Manual Committee over the past three years of redevelopment are listed on page 2. A complete list of Service Associate members appears on the inside back cover.

We sincerely hope that this Manual will prove helpful both in stimulating renewed interest in effective maintenance planning and in actually carrying out such plans. We remain eager to obtain suggestions and criticisms of this Manual to aid in making future improvements.

Harold P. Seamon
Executive Director
Illinois Association of School Boards

Contributors

This Manual is the product of many writers and editors, as well as numerous individuals who contributed suggestions and critical comment.

Over-all responsibility for the Manual rests, of course, with the IASB Service Associates Maintenance Manual Committee, the Senior Editor Jack T. Harroun, and the IASB Communications Department, which handled final editing and production.

Of particular importance are those individuals who drafted sections, chapters, or other items for the Manual. They provided the basic expertise. The IASB Service Associates acknowledge the following individuals as original authors and/or supervising specialists for each section in the Manual:

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3. Safety – Maintenance Manual Committee

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20. Sewage Treatment Plants – **Walter G. Kimmel**, Kimmel-Jensen-Wegerer-Wray. Credit also is due the Ohio Trade and Industrial Education Service (septic tank systems) and Brown, Davis, Mullins and Associates (extended aeration systems).

21. Lighting and Lamps; Fire Alarm Systems; Circuit Breakers – **Charles R. Kuglin,** Childs and Smith, Inc.

22. Motor Starters – **Lowell N. Peterson,** Beling Engineering, and **R. W. Bardach**, Peabody, Gordon-Piatt, Inc.

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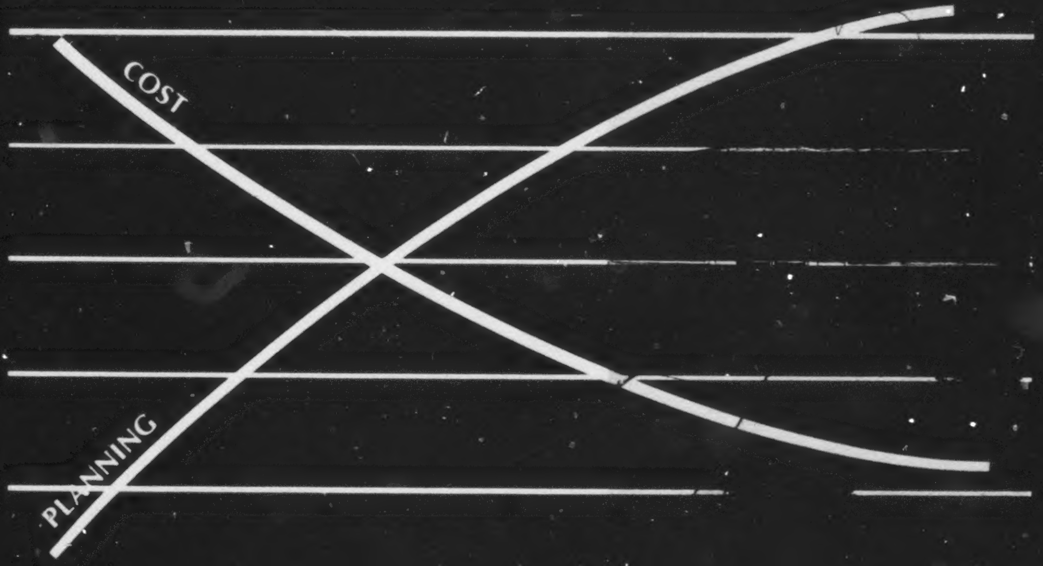
24. Annual Inspection Check Lists – **Gene Swager** and **Charles Henriksen,** Phillips, Swager and Associates; **Ward Jensen**, Kimmel-Jensen-Wegerer-Wray; **Roy Conrad**, Beling Engineering


COST
PLANNING

BASICS

of good school maintenance

Managing
a School Maintenance Program

Management is getting things done through other people. It involves directing others. It involves the coordination of manpower, machinery, money, and materials.

Based on this brief definition, the school maintenance manager is responsible for the following management functions:

1) Planning – A school maintenance program begins with a description of the services to be performed, a clear statement of how well those services are to be performed, and a budget that is consistent with the desired level of service and performance. Once the maintenance manager possesses all of this information, he will know what is expected of him and he can begin to organize the manpower, money, and materials at his disposal to get the job done.

In planning, the maintenance manager must deal with three basic types of plans:

- Daily, weekly, and monthly plans
- Short range plan (one year)
- Long range plan (three or more years)

Such plans help the maintenance manager prepare a realistic budget and they act as a guide. Should an emergency force deviation from the plans, it is essential to return to pre-planned objectives or goals. Periodic review of all plans enables the maintenance manager to determine where and how far the maintenance program may have strayed off course.

2) Organization – The purpose of organizing is to obtain the maximum benefits with the least effort and cost. Budgeted dollars available for manpower, equipment, and supplies frequently do not measure up to the tasks that need to be performed. Thus, the maintenance manager is constantly challenged to find more efficient ways of doing things.

The critical elements required to properly organize maintenance operations are:

a) *The organization of work.* Establish priorities so that the critical tasks receive attention first. Establish the proper sequence of activities necessary to complete the tasks.

b) *The organization of people.* While this may include an organization chart, it must include job descriptions for all employees and reflect the number of daily man-hours available, broken down into the various skill classifications.

Organizational tools help the maintenance manager find new ways to combine available manpower, materials, and equipment in order to increase the maintenance team's productivity. It also enables him to "match-up" the available manpower and materials with the workload.

3) Match-up – The maintenance manager must constantly evaluate the maintenance workload in terms of time required to complete the tasks and the skills required. The manager then allocates the necessary man-hours, materials, and skills to complete the assignments.

4) Pre-assigning – The maintenance manager, prior to the time that work must be assigned, should prepare batches of work, work orders, or individual work tasks. Each task should be assigned a known time value for completion. When assigned a measured amount of work, the maintenance staff member should be informed of the expected rate of production and expected time of completion.

5) Follow-up – The vast majority of maintenance employees are sincere in wanting to do a good job. Through proper organization, coordination, and follow-up, the maintenance manager must ensure that employees are indeed able to function effectively. The manager must provide all maintenance team members with:

- An achievable goal
- A basis for gaining recognition
- A basis for measuring their own performance
- A basis for developing pride and self-esteem by knowing they have done a good job within the parameters set by management.

In addition, of course, the maintenance manager must see that satisfactory progress is made toward goals and objectives and that tasks are completed at reasonable cost. For all of these reasons, the maintenance manager must keep extensive records that reflect departmental performance and progress toward goals. His follow-up must lead to the improved performance of individual employees as well as to improved planning and organizing.

The thrust of this manual is directed at increasing the efficiency of the maintenance team. Material in subsequent chapters emphasizes the importance of planning maintenance tasks and organizing and executing them in an efficient sequence. Particular attention is given to the planning and organizing of:

- Personnel
- Assignment of tasks
- Standards
- Time
- Procedures
- Equipment
- Costs

Conserving Energy

Our costly and limited natural resources

Much of the energy consumed in the United States is simply wasted or unnecessary. Accustomed to seemingly unlimited fuel sources at low costs, Americans have fallen into a pattern of energy usage that must be reversed.

The spiraling cost of energy alone should be justification for bringing energy consumption under control. Recognition of the fact that energy sources are indeed finite is perhaps the best reason of all, for a world without energy is unimaginable.

School maintenance personnel are on the front line of energy conservation. The vast physical plants for which they are responsible offer innumerable opportunities to conserve energy resources and to carve out huge savings in expenditures for heating, lighting, and building operations.

The following list is by no means exhaustive, but it does provide a large step toward efficient energy use.

GENERAL

1) Conduct in-depth energy cost studies. Use consultants when and where necessary to review and implement energy savings programs.

2) Involve building maintenance people, staff, and students in energy reduction programs. Provide data on actual savings or results of energy conservation programs. Share results data with staff and students in an imaginative manner.

3) Provide printed decals stressing energy conservation and mount them in appropriate places (at light switches, for example).

4) Curtail or carefully review requests for building usage for nonschool activities.

5) Consolidate night usage of building.

6) Install storm sash.

7) Install weather stripping on windows and doors.

8) Increase or install wall and/or roof insulation.

9) Keep doors and windows closed.

HEATING AND VENTILATING SYSTEMS

1) Encourage all occupants to wear warmer clothing. Lower the building temperatures to the following:

Gymnasium – 65°F.
Unoccupied areas, storerooms, etc. – 55°F.
Shops – 65°F.
Rest rooms, corridors – 65°F.
Other occupied areas – 68°F.

2) Reduce building temperatures when unoccupied as follows:

Overnight – 60°F.
Weekends, and all other periods of nonuse – 50° to 55°F.

3) Place building on night setback at the time classes are dismissed. It is not necessary to maintain day settings for stragglers, as the building will maintain temperatures for at least an hour.

4) Close blinds and drapes after school to conserve building heat in the winter and to keep solar heat out in the summer.

5) Reduce outside air ventilation rates to those required minimums stipulated in the current State of Illinois Circular Series A-157 and A-156.

6) Do not introduce outside air during unoccupied hours.

7) Turn off exhaust fans when not in use and when building is unoccupied.

8) Your regularly scheduled maintenance program should include the following:

Replace or clean filters.
Clean or adjust temperature control.
Clean heat transfer surface.
Adjust dampers.
Clean and repair steam traps.
Adjust burners to optimum combustion efficiency.
Clean boiler fire surfaces.
Treat boiler water to avoid scale deposits.

ELECTRICAL SYSTEMS

1) Turn off lights when a room is unoccupied.

2) Minimize the amount of lighting used for night cleaning.

3) Reduce lighting in nonessential areas, storage areas, and corridors.

4) Review general lighting levels in brightly lit areas, such as libraries and cafeterias, and reduce illumination.

5) Clean fixtures and replace lamps regularly. Fluorescent lamps should be replaced after 80 percent of lamp life has been used.

6) Decorate rooms and dividers with colors that reflect light. Keep wall, ceiling, and floor surfaces clean.

7) Use fluorescent light fixtures wherever possible. They are four times more efficient than incandescent light fixtures.

PLUMBING SYSTEMS

1) Reduce temperature of general-use hot water to a maximum of 130°F.

2) Repair all leaking faucets.

3) Control discharge of water from shower heads to a maximum of 3 GPM by using flow control devices.

Some suggestions for

Safe Maintenance Practices

Safety has a special priority in the public schools. School management must have as its first concern the physical safety of the boys and girls who are required to be there each day. For the maintenance team, this means giving continuous attention to all aspects of the building structure and equipment. It also means that each member of the team must acquire a mind-set – a deep sense of personal concern – that compels him to investigate any suspicious or unexplainable conditions.

In addition to the safety of those who work and learn in the schools, the maintenance team itself faces each day some special circumstances that call for caution. Certain equipment and chemicals, for example, may create perils for the thoughtless or unwary user. It is essential, therefore, that each team member understand the potential perils, the limitations of his tools, and the ways of going about his job without creating unnecessary hazards.

In its day-to-day work, the maintenance team is primarily concerned with the proper use of equipment and materials. What follows are some guidelines for the safety-conscious maintenance team.

1) **Aisles and passageways** – Keep aisles and passageways clear and in good repair with no obstruction across or in aisles that could create hazards.

2) **Compressed air** – In using compressed air for cleaning purposes, do not exceed 30 psi and then only with effective chip guarding and personal protective equipment.

3) **V-belt drives** – Guard the V-belt of all drill presses, including the usual front and rear pulleys, to protect the operator from contact or breakage.

4) **Emergency flushing** – Where the eyes or body of any person may be exposed to injurious corrosive materials, provide suitable facilities for quick drenching or flushing of the eyes and body within the work area for immediate emergency use.

5) **Eye and face protection** – Protective eye and face equipment is required where there is a reasonable probability of injury that can be prevented by such equipment.

6) **Fan blades** – Guard the blades of a fan. The guard should have openings no longer than ½ inch. The use of concentric rings with space between them, not exceeding ½ inch, is acceptable provided they are adequately supported.

7) **Fire doors** – Do not block fire doors or tie them in an open position. Locate fusible links for fire doors so as to properly function in case of fire. Do not paint them. Three three-inch diameter vent holes, cut through the metal only, are required for tin-clad fire doors up to nine feet in height. (An additional vent hole is required for doors from nine feet to 12 feet, four inches in height.) Secure the metal covering around the opening with small nails and paint the exposed wood thoroughly.

8) **Fire protection** – Provide and maintain in an effective operating condition portable fire extinguishers suitable to the conditions and hazards involved. Conspicuously locate and mount them where they are readily accessible and do not obstruct or obscure them from view. Give maintenance service to portable fire extinguishers at least once a year, with a durable tag securely attached to show the maintenance or recharge date. In storage areas, clearance between sprinkler system

deflectors and top of storage varies with the type of storage. For combustible material stored over 15 feet but not more than 21 feet high in solid piles, or over 12 feet but not more than 21 feet high in piles that contain horizontal channels, the minimum clearance is 36 inches. The minimum clearance for smaller piles or for noncombustible materials is 18 inches.

9) Flammable liquids - Can be highly hazardous to life and property. Check with local fire department officials for recommendations.

10) Floors -- Keep all floor surfaces clean, dry, and free from protruding nails, splinters, loose boards, holes, or projections. Where wet cleaning is used, maintain drainage; where practicable, provide false floors, platforms, mats, or other dry standing places.

11) Hand tools – Keep tools and equipment clean and in safe condition.

12) Housekeeping – Keep clean, orderly, and in a sanitary condition all places of employment, passageways, storerooms, and service rooms.

13) Ladders, fixed – Design all fixed ladders for a minimum concentrated live load of 200 pounds. The minimum diameter of all rungs is:

- ¾ inch if metal;
- one inch if the ladder is constructed of metal rungs embedded in concrete and exposed to a corrosive atmosphere;
- 1⅛ inch if the ladder is wooden.

Spaced not more than 12 inches apart, the rungs should have a minimum clear length of 16 inches. Paint or treat metal ladders to resist corrosion or rusting when the location demands.

14) Ladders, portable – Equip stepladders with a metal spreader or locking device of sufficient size and strength to securely hold the front and back sections in open position. Maintain ladders in good condition, and withdraw defective ladders from service. Erect non-self-supporting ladders on a sound base at a 4-1 pitch and place to prevent slipping. The top of a ladder used to gain access to a roof should extend at least three feet above the point of contact. Coat wooden ladders with a suitable protective material.

15) Stationary electrical devices – Ground all stationary electrically powered equipment, tools, and devices located within reach of a person who can make contact with any grounded surface or object.

16) Storage – Stack, block, interlock, and limit in height all storage so that it is secure against sliding or collapse. Keep storage areas free from accumulation of materials that constitute hazards or pest harborage. Exercise vegetation control when necessary. Where mechanical handling equipment is used, allow safe-clearance for aisles, at loading docks, and through doorways.

17) Trash – Collect and remove trash and rubbish in such a manner as to avoid creating a menace to health, and as often as necessary to maintain good sanitary conditions.

Designing Buildings for Efficient Maintenance

The design of a building has a great impact on maintenance. A building can be designed to make maintenance relatively easy and low in cost. Such things as efficient traffic patterns, strategically located storage areas, and easy access to mechanical equipment can save thousands of dollars every year – over the entire life of the building – by eliminating needless building wear and inefficient maintenance work. Building materials, too, can be selected for ease of maintenance – a characteristic which can quickly offset a substantially higher first cost. The following inventory is useful for remodeling existing buildings, as well as for building new ones. Generally, the extra one-time cost of installing low maintenance items is recovered in the first couple of years of operation. This list is incomplete, but it does offer ideas on what to look for.

GENERAL

1) Have safety requirements been considered?
2) Is there easy access to all mechanical equipment for maintenance personnel?
3) Is there a separate adequate main custodial storage area?
4) Are there adequate custodial closets on each floor?
5) Are the doors to all mechanical equipment rooms wide enough to get equipment in and out?
6) Review the filter cleaning procedure.
7) Is there adequate clearance in boiler areas for use of cleaning equipment?
8) Consider maintenance traffic; does it cross occupant areas? Can this be avoided?
9) Are there floor-type service sinks with adequate cleanout drains in custodial and other maintenance areas?
10) Where lockers are provided, use lockers with closed bases and slanted tops to minimize cleaning. Consider expanded raised locker base for a seating area.
11) Before occupying building, see that complete operational and maintenance manuals are provided for all equipment. Also, plan for maintenance personnel to receive operating instructions.
12) Is there adequate floor drainage?
13) Check ventilation in custodial areas.
14) Provide shelving, hooks, lighting, etc. for custodial storage areas.
15) Check lighting and electrical outlets for adequacy.
16) Review trash removal pattern from the building, including the locations of any elevators.

BUILDING EXTERIOR

1) Consider ramps in place of steps and be sure that people with disabilities have access to the building.
2) In landscape planning, use low maintenance profile plant materials. Avoid handwork when possible. Lay out walks and plant materials to discourage people from walking on lawns. Review traffic patterns, such as from parking lots to building entrances.
3) In Illinois, avoid placing entrances on the north side of the buildings. Ice and snow removal problems are aided by the sun when north exposures are avoided.
4) Provide secure water faucets on building exterior every 100 feet or so for window

washing, watering plants, etc.

5) Consider the emergency use of fire fighting equipment and locate plant materials and walks accordingly.
6) Is drainage adequate for walks, entrances, lawns, and parking areas?

BUILDING INTERIOR

1) Use medium colored floor coverings and choose materials which show minimal soil.
2) Use dark baseboards and choose materials that resist damage.
3) If floors are exposed to heavy loads, select floor covering that can withstand the wear.
4) Avoid interior steps or similar obstacles to the movement of equipment or to the use of cleaning equipment.

REST ROOMS

1) In planning washrooms, check traffic flow and locate fixtures accordingly. Mirrors and shelves located away from lavatories will aid traffic flow.
2) Check washroom accessibility.
3) Are toilet facilities and space adequate in terms of occupant use?
4) Are floor drains adequate?
5) Is there storage for toilet room supplies?
6) Is ventilation adequate?
7) Use nonporous floors, walls, and ceilings which are easily cleaned and do not contribute to fungus growth or conditions creating odors.
8) Use wall-hung urinals, commodes, partitions, wash basins, and sinks. Close in pipes wherever possible under wash basins. Use open-throated urinals.
9) Select partitions which are easily cleaned and maintained.
10) Provide adequate dispensers for soap, towels, toilet paper. Use double toilet paper holders and extra towel cabinets to reduce extra time for servicing.
11) Fixtures should not be visible from entrance door.
12) Provide an adequate number of electrical outlets.
13) Since toilet floors are water mopped frequently, make them as free and clear as possible.

WINDOWS

1) Reduce energy waste (air conditioning and heating losses) by reducing the number of windows and/or using storm sashes.
2) Reduce dust-catching surfaces.
3) Review window-cleaning requirements in choosing window types.

WALLS

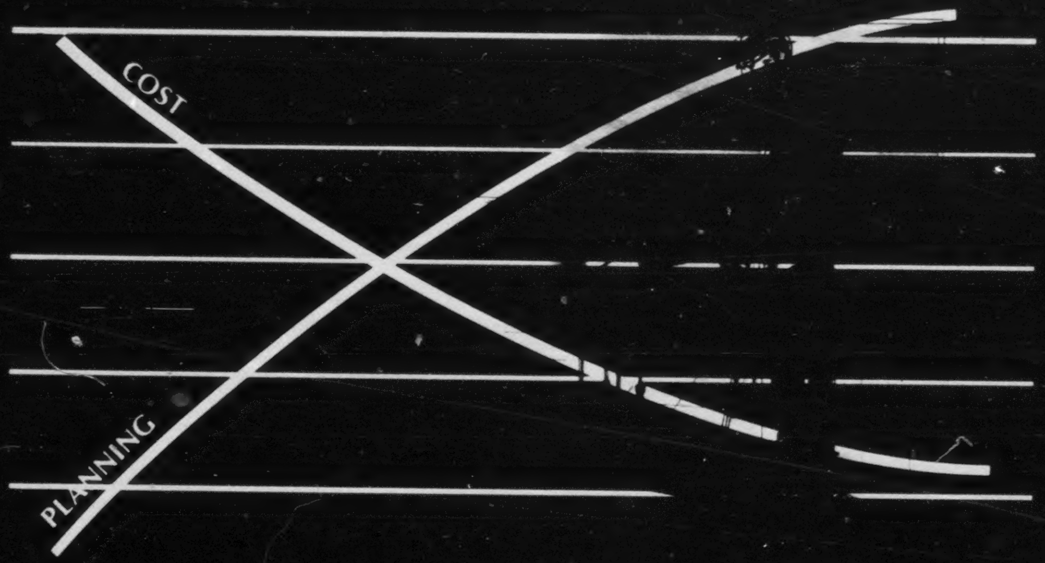
1) Locate fire extinguishers in recessed, breakable glass wall cases.
2) Review wall cleaning procedures and choose the best type of wall coverings.
3) Use wall-hung water fountains and use protective wall coverings.
4) Use dark baseboards.

ELECTRICAL SERVICE

1) Review electrical systems for energy conservation.
2) Ground all receptacles.
3) Review building use and provide an adequate number of outlets to reduce the use of extension cords.
4) Are all electric motors easily accessible for periodic maintenance?
5) Consider the use of key switches in public areas.
6) Is lighting adequate and easy to clean? Is replacement of bulbs convenient?
7) Are exit lights properly located?
8) Is exterior lighting adequate and on automatic control?
9) Review provisions for telephones.

FLOORS

1) Stock extra tile of each pattern and color for replacements.
2) All hard floors, such as concrete or terrazzo, should be sealed.
3) Use medium colored floor coverings for ease of daily maintenance.
4) Use carpeting in entrances and elevators to collect and hold soil.
5) Do not use resilient tile floor coverings in areas that are water mopped daily.



General Building Maintenance

Cleaning

and General Building Services

Routine maintenance of school buildings is essential because it affects the safety and well-being of all users, including students and teachers. In order for the maintenance team to achieve above-average productivity, the supervisor must ensure the organization of at least the following:

- Personnel
- Responsibilities
- Principles
- Tasks
- Standards of cleanliness
- Time
- Task procedures
- Equipment
- Budget (man-hours per 1,000 gross square feet)

PERSONNEL

Organization of people includes an analysis of how work crews are used in coordination with area cleaning assignments (or stations). There usually are several possible combinations of crews/areas/assignments, one of which is bound to be most efficient.

Fair work loads, as well as productivity, depend on proper organization. Since work loads vary, it might be best to organize work arrangements along these lines:

1) **Use large areas** where one person performs most, if not all, of the services. (This represents an area or station cleaning assignment.)

2) **Use back-up crews** to fill in area or station vacancies first and to perform periodic work (such as window washing or floor maintenance) when they are not needed for areas or stations.

TASK RESPONSIBILITIES

Organize task responsibilities in writing so that workers know what they are responsible for and how their tasks interrelate. In a school, the general building maintenance responsibilities might be listed as follows:

1) Routine sweeping and/or mopping of floors; the dusting of trim, furniture, tops of desks and tables (when free of material and/or apparatus), bookcase glass, window ventilators, telephones, desk lamps; the emptying of independent, floor-type waste containers, ashtrays, and disposal of debris.
2) Periodic cleaning, buffing, and waxing of floors and the cleaning of windows and venetian blinds.
3) Cleaning of blackboards (unless otherwise requested), chalk trays, and the replacement of chalk and erasers as necessary.
4) Closing and locking all windows.
5) Cleaning of drinking fountains and all plumbing fixtures.
6) Furnishing of materials and supplies re-

quired for the above and the supply of toilet paper, towels, and liquid hand soap where dispensers are installed.

7) Collection and removal of trash.
8) Cleaning of mirrors and interior glass.

CLEANING PRINCIPLES

Some cleaning principles useful in guiding members of the building maintenance staff are as follows:

1) Cleaning personnel and their work are important.
2) Productive cleaning is programmed when the area to be cleaned is vacant or has a period of low occupancy.
3) The established standard of cleaning must be appropriate to the area being served if reasonable costs are to be achieved.
4) Occupants' habits have a direct effect on the standard of cleanliness and costs.
5) Inadequate cleaning facilities increase cleaning costs by increasing unproductive time.
6) Modern management concepts must be used.
7) Avoid using custodial personnel for personal tasks or errands, since this results in unproductive time, excessive costs, and dirty buildings.
8) Make the job as interesting as possible by including various types of tasks in one work assignment.

GENERAL BUILDING MAINTENANCE TASKS

General building maintenance tasks can be organized into *daily*, *periodic*, and *special* task groupings. This list is not all inclusive and other tasks may be added:

1) **Daily tasks**
   a) Floors
      - Wet clean toilet floors
      - Vacuum carpets
      - Dust mop most hard and soft floors
      - Entrances
   b) General dusting
   c) Waste removal
   d) Clean inside glass and mirrors
   e) Clean fixtures (water fountains, toilet fixtures)
   f) Clean chalkboards
   g) Spot and emergency cleaning
   h) Close/raise windows and turn off lights
   i) Lock and unlock doors
   j) Report repairs needed
2) **Periodic tasks**
   a) Floor sealing
   b) Floor refinishing
   c) Floor buffing
   d) Carpet spotting
   e) Carpet shampooing
   f) Carpet pile lifting
   g) Window washing
   h) Screen cleaning
   i) Venetian blind cleaning
   j) Drapery cleaning
   k) Wall washing
   l) Furniture waxing
   m) Upholstery vacuuming
   n) Swimming pool cleaning
   o) Snow removal
3) **Special or seasonal tasks**
   a) Lawn care
   b) Tree care
   c) Shrub care
   d) Heating and ventilation responsibilities
   e) Painting
   f) Training
   g) Limited furniture moving and repair
   h) Limited setups
   i) Sanitary napkin vending operation
   j) Limited custodial supply delivery
   k) Limited supply and equipment testing

STANDARD OF CLEANLINESS

To organize and achieve the desired standard of cleanliness, the following items must be considered:

1) The standard of cleanliness must be appropriate to the area serviced.
2) The standard of cleanliness must avoid overcleaning, as well as undercleaning.
3) It should be understood that cleaning for appearance is expensive.
4) The standard of cleanliness is based primarily on:
   - Service performed
   - Frequency of that service

- Work skills
- Habits of occupants

ORGANIZATION OF TIME

The best time to schedule maintenance is during periods when the area is vacant or has low occupancy. For example, clean and refinish the floors during school vacation periods.

Unscheduled or emergency work should be done based on need and urgency. Each need must be studied and a decision made for best cost results.

ROUTINE TASK PROCEDURES

It is essential that persons performing any given task understand in detail all of the procedures that are involved. He must know, for example, such things as:

- What the task is intended to accomplish.
- How the task is to be performed.
- Standard of cleanliness required.
- Frequency of the task.
- Equipment and supplies needed and how they are used.
- Any safety or other considerations.

The procedures suggested for ten routine tasks commonly called for in any public school are set forth on pages 22 through 30.

EQUIPMENT AND SUPPLIES

The right equipment in the proper amount at the right place at the right time (and in good condition) is necessary for productive cleaning. Assign specific responsibility for equipment and supplies. Remember, unused equipment represents a poor investment and reflects unfavorably on everyone. Also, professional custodians know how to use all types of equipment productively. This is part of their skill and work knowledge.

Examples of some basic supplies and equipment, how they are used and cared for in school cleaning are presented on pages 31 through 38.

BUDGET ORGANIZATION

The financial plan or guide is the major control over other considerations in maintenance, so that budget flexibility should be encouraged along with responsible management. Rigid budgets stymie leadership, stops needed improvement, and tends to stagnate the operation. Expect all members of the maintenance team to produce and operate an economical program.

Custodial studies indicate, in general, that the cleaning dollar is divided as follows:

- 90 to 95 percent for labor
- 5 to 10 percent for material and equipment

TIME STANDARDS

There are many uncontrollable variables in custodial services caused by such items as the building (design, use, age, state of repair), custodial facilities, undefined responsibilities, purchasing regulations, personnel aspects, union agreements, benefits, untrained supervision, occupant demands, building size, and geographic location. However, the following organization of time appears to be a reasonable starting place with the understanding that *locally developed standards are the best*. Well-managed programs in large buildings should do better than this guide.

1) Based on once-a-day frequency and a five-day school week, an *institutional standard of cleaning* is possible using 125 to 200 annual man hours per 1,000 square feet (gross) of floor space.

2) The list indicated under "General Building Maintenance Tasks" (page 19) covers custodial services and their suggested frequency and represents the general cleaning needs for school buildings. While it must be understood that the list is not all inclusive, with proper local management it should be adequate for most school buildings.

3) A dollar value is reached by multiplying 125 to 200 times the average hourly custodial pay

rate for the particular institution, times the number of units of 1,000 square feet gross of floor space. The dollar value represents all normal custodial costs.

Here is an example of a Task Time Breakdown, based on 150 man hours per 1,000 gross square feet:

Services	%	Man hours per 1000 sq. ft. (gross)
Floors (daily)	20	30
Floors (periodic)	20	30
Dusting	8	12
Waste removal	10	15
Glass cleaning	7	10.5
Fixture cleaning	12	18
Entrance cleaning	2	3
Furniture waxing	1	1.5
Locking/unlocking	2	3
Closing/raising windows, etc.	1	1.5
Repairs reporting	3	4.5
Spot cleaning	1	1.5
Wall washing	1	1.5
Miscellaneous	12	18
	100%	150

CONTROLS AND REPORTS

In even the smallest school operation, some form of control is essential to see that work is properly and fairly assigned and that it is completed satisfactorily. While much of this is accomplished through personal supervision and inspection, accurate communication and record keeping depends heavily on an efficient system of written instructions and reports.

It is possible to rely too heavily on written reports. Such reports, for example, are no substitute for positive personal interaction between the supervisor and those who work for him. The human element is essential in such aspects of supervision as training, instructing, and correcting. Moreover, excessive use of written reports becomes counterproductive whenever the time spent filling out a form becomes greater than the time saved by increased control.

There are, however, certain kinds of reports which are extremely useful in getting routine information to and from members of the maintenance team. These reports save time, provide information essential to effective management control, and need not be a burden on the total team effort if everyone understands how and why they are used.

Experience shows that the following report forms are effective in most school maintenance operations:

- Custodial Area Assignment
- Work Reports (daily or periodic) for area cleaning, floor maintenance, window washing, carpet and upholstery work, and supply orders.

Examples of these reports are provided in the Management Tools Appendix, pages 114 to 116.

WORK INSPECTIONS

Work inspections may be formal or informal, but the philosophy is the same for all inspections, and that is "to help everyone do a better job." In general, this means the supervisor should compliment good work, and not disregard but seek improvement in poor work.

A personal visit to the work area remains one of the best controls. Such a visit is most helpful when it results in written information on work, equipment, supplies, etc. Among other things, these reports provide a basis for future inspections, because they point out weak and strong points.

Sample inspection reports are presented on pages 117 through 122 in the Management Tools Appendix. In addition to the examples provided, some school districts effectively use "occupant reports" to help determine how teachers and others feel about the level of maintenance services. Such reports may or may not depend upon a particular form. If a form is desired, it is best developed locally.

SUGGESTED PROCEDURES FOR ROUTINE CUSTODIAL TASKS

1. DRY MOPPING

Dust mopping makes it possible to clean floors rapidly and, with proper use of the mop, to maintain a high standard of cleanliness. Many school areas are dry cleaned with a cotton strand mop treated with a dust controllant.

Frequency: Daily

Equipment: Dust mop and wedge dust mop.

Procedure: Dust mops are used daily to remove litter, soil, and dust (*after* dusting so anything brushed to the floor will be cleaned up) from various types of floors, such as concrete, cork, terrazzo, asphalt tile, rubber, linoleum, and wood.

When dust mopping, move through the assigned area in a pattern adjusted to the local situation. Generally, this movement is in a clockwise or counterclockwise pattern, pushing the dirt to the main aisle for pickup. (See Figure 1) Mop closely around legs of equipment, baseboards, corners, and behind open doors. Avoid doubling back, since this can be unproductive.

Dust is removed by shaking or brushing the dust mop. In shaking the mop, avoid walls and corners, and keep it low so that the dust isn't scattered into the air. Use a dust pan and counter brush to pick up dust piles. Always remember to pick up dirt after shaking the mop. Never shake the mop outside the building onto the ground. Remop the area of the dust pile after it is picked up.

Safety: Concentrate on safe movements at all times, particularly in congested areas such as laboratories or on stairways. Alertness is the best guard against accidents.

2. DUSTING

Removal of dust from equipment and furniture is essential. Proper dusting involves *removal* of the dust – not brushing it from one location to another. (See Figure 3)

Frequency: Flat surfaces that are free of material should be dusted daily. Vertical surfaces may be dusted less frequently (weekly). All dusting should be scheduled to cover the entire work area.

Equipment: Duster handle and short strand cotton duster.

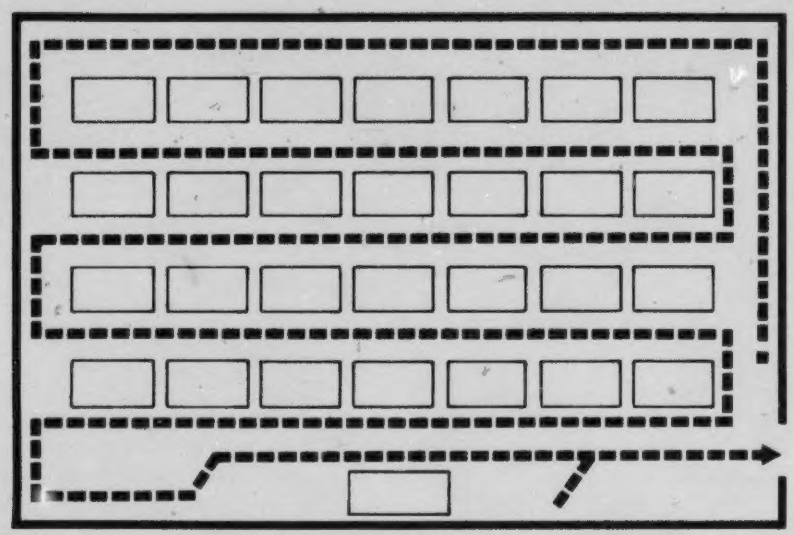


FIGURE 1—Dry mopping pattern must be adapted to room and equipment layout. Pattern illustrated here is suitable for most traditional classrooms.

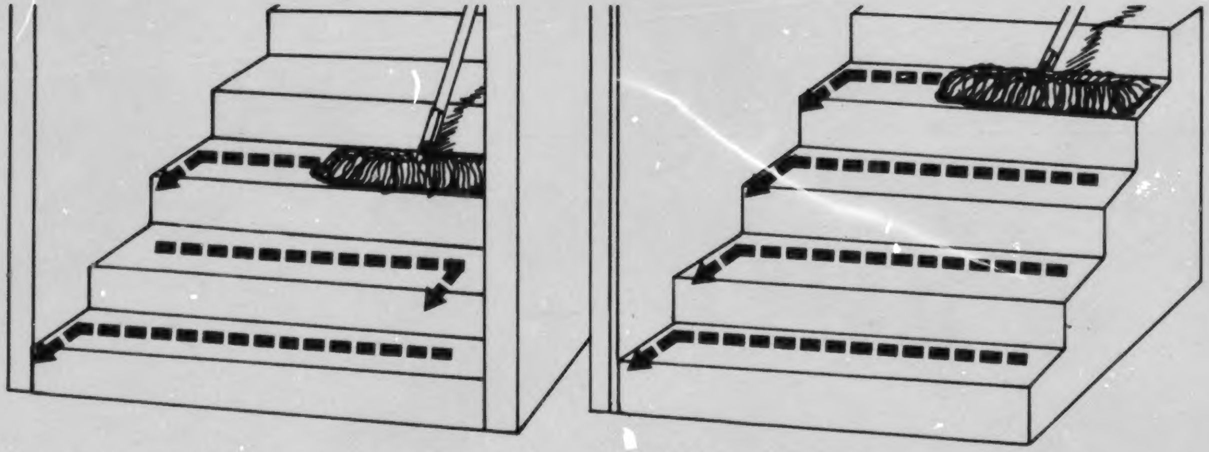


FIGURE 2—For best results on enclosed stairs (left) dry mop in alternate directions. On partially open stairs (right) mop only in one direction—toward the enclosed side.

Procedure: The cotton duster, mounted on a handle and treated with a dust controllant, is used to pick up dust. All desks, tables, and similar flat surfaces free of material may be dusted. Normally, papers, pictures, research equipment, or similar equipment are *not* moved in order to dust. It is the responsibility of the building occupants to leave the flat surfaces of their work areas free of objects if they are to be dusted.

3. TOILET CLEANING

Clean, well-ventilated toilets have no objectionable odors.

Frequency: Daily and periodic tasks.

Equipment and supplies: Abrasive pads, acrilan swabs, push broom, towels, dust pan and counter brush, glass cleaner, liquid hand soap, mop bucket and wringer, pads of cloth, rubber gloves, hand duster, toilet tissue, and all purpose cleaner and water (mixed at the rate suggested by the manufacturer for water mopping and cleaning toilet fixtures).

General procedure: Develop a pattern in toilet cleaning which eliminates doubling back and extra trips to custodial storage areas. This operation requires initiative in planning efficient work patterns.

Daily procedure:

1) Empty all waste containers and replace them in proper location.
2) Dust all window ledges, towel cabinets, and trim, such as doors, chair rails, baseboards, etc.
3) Replenish supply of toilet paper, sanitary napkin bags, towels, and soap where dispensers are provided.
4) Clean glass.
5) Clean all fixtures (inside and outside), such as wash basins, service sinks, urinals, stools, showers, etc.
6) Clean toilet seats and hardware.
7) The following steps should be followed when cleaning stools and urinals: Flush urinal or stool. Reduce water in the fixture by forcing it over the trap with an acrilan swab. Press water from the swab. Using the acrilan swab with cleaner, scrub the inside area of the fixture, especially under rims, the trap area, and the water line. A second or third application may be necessary to remove stubborn stains. Rinse the fixture and the swab by flushing the fixture. Bowl cleaner or abrasive cleanser is to be

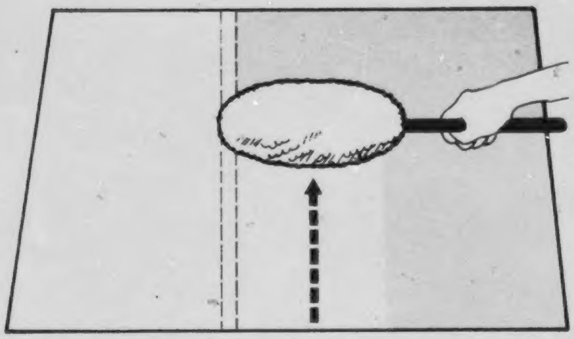


FIGURE 3—In dusting, overlap the clean area to avoid missing any of the flat surface.

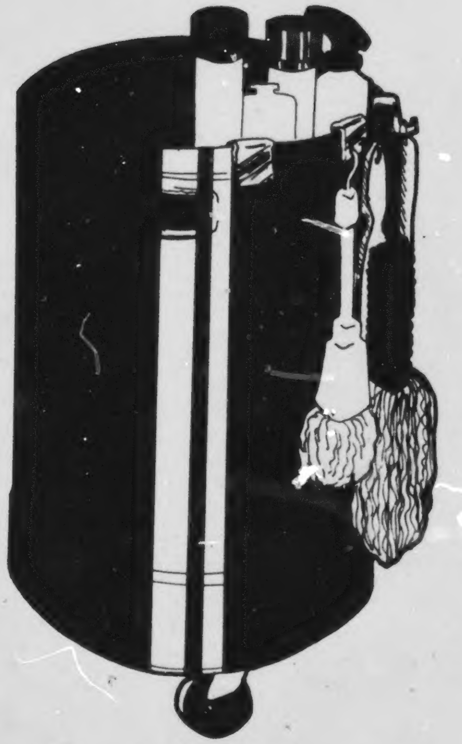


FIGURE 4—A utility can on casters can be equipped with basket and hooks to carry needed supplies and equipment.

used only in special cases. *Do not mix bowl cleaner with any other cleaner.* Handle bowl cleaner carefully and avoid contact with the skin or prolonged breathing of fumes.

8) Remove drawings and writing from walls, partitions, doors, etc.
9) Wet mop toilet floors.
10) Replace burned-out lights.
11) Clean tools and supplies and properly store them in a custodial storage area.

Periodic procedures:

1) Wash walls.
2) Wash painted surfaces and doors.
3) Clean difficult areas.
4) Remove stubborn stains.
5) Dust overhead pipes, etc.
6) Clean spattered wall areas near fixtures.
7) Remove cobwebs, etc., from corners and ceilings.
8) Clean accumulated dust, lint, and dirt from radiator sections.

4. WASTE PICKUP

Frequency: Daily

Equipment: Custodial cart

Procedure: Emptying waste receptacles and gathering paper and trash are usually the first tasks done each day. Develop a straight-line pattern of waste pickup and avoid doubling back. Do not bump walls, doors, or equipment with the custodial cart. In moving the cart, it is usually easier to push it than to pull it. Reduce the flying dust from trash by turning the wastebasket over and holding it down in the receptacle when emptying.

Caution: Do not use bare hands to pack waste in the custodial cart, since waste may contain sharp material or glass. Pack down waste with an empty wastebasket. Use proper lifting techniques to avoid back injuries. Always test weight of wastebasket before lifting. Avoid overloading of custodial cart with waste.

5. WATER MOPPING

Frequency: Daily and periodic

Equipment: All-purpose cleaner, mop handle, cotton mop head, and gear press mop unit.

Procedure: The water mopping procedure is used to clean various types of floors. Entrances are wet mopped as needed. With the wet mopping procedure, soil is removed in two ways. First, the cleaner with its chemical action loosens dirt. Then, the mop picks up soil as it moves back and forth over the floor. *Too much water on soft floors may cause damage.* Wet floors are hazardous, so traffic should be controlled while the area is water mopped. The rinsing procedure is important since it accomplishes two things: Soil is removed, and the excess cleaner is picked up. If permitted to remain, the cleaner might build up or cause floor damage.

Helpful hints:

1) If baseboards are spotted and splashed, spot clean them promptly. To avoid spotting and splashing baseboards, water mop a strip along the baseboard so that later mop swinging is away from the baseboard.
2) Use side-to-side, overlapping strokes. Overlap areas that are water mopped to avoid lap marks.
3) Change cleaning solution as soon as it is dirty. This prevents a streaky floor appearance. The mop head should be turned

periodically.

4) Avoid striking walls or furniture with the mop. Wipe off mop marks promptly, because they leave stains.
5) Proper wringing procedure is important. Use the left hand to hold the mop in the center of the wringer, and use the right hand to push the wringer handle down. Then, keeping hold of both, bring your body weight down on the wringer handle. Do this by flexing the knees and keeping the arm straight. Wring tightly, but do not twist the mop excessively.
6) Be careful not to hit the ceiling lights with the mop handle. Remove the mop and shake it to fluff the strands.

Care and storage: Thoroughly clean all equipment and neatly store it in a secure storage area. Always clean and rinse out the wet mop and store it in a mop rack. Dry out mop bucket before storing. A professional cleaner can be identified by the state of the cleaning equipment.

6. VACUUM CLEANING

Regular vacuum cleaning increases the life of carpets by removing sharp, gritty particles that grind rug fibers.

Frequency: Periodic

Equipment: Three types of vacuum cleaning machines are available. The choice depends upon the requirements of a particular job:

1) Wet-dry vacuum cleaners are used to remove liquids.
2) Upright and brush-type vacuum cleaners are used on carpets to agitate the pile and remove the soil by air movement.
3) Tank-type dry vacuum cleaners are used for dusting or carpet cleaning.

Procedure: A slow movement one time over the area to be cleaned is preferred rather than several fast, short, back-and-forth movements. When the flow of air is stopped or obstructed, the vacuum machine cannot clean. All cloth soil bags should be emptied after each use so the flow of air through the soil bag is not stopped by dust lodged in the inner surface of the bag. Always empty and shake the cloth soil bags after each use and the vacuum cleaner will operate more efficiently. Paper soil bags should be replaced when the soil in the bag obstructs the flow of air. The metal soil containers of the wet-dry machines should be emptied and cleaned after each use.

7. WAXING FURNITURE

Office and classroom furniture, such as desks, chairs, tables, and files, should be cleaned and waxed regularly.

Frequency: Periodic

Equipment: All-purpose cleaner, cheesecloth or similar cloth material, furniture wax, and pail.

Procedure: The custodian is normally responsible for the waxing of furniture located in the

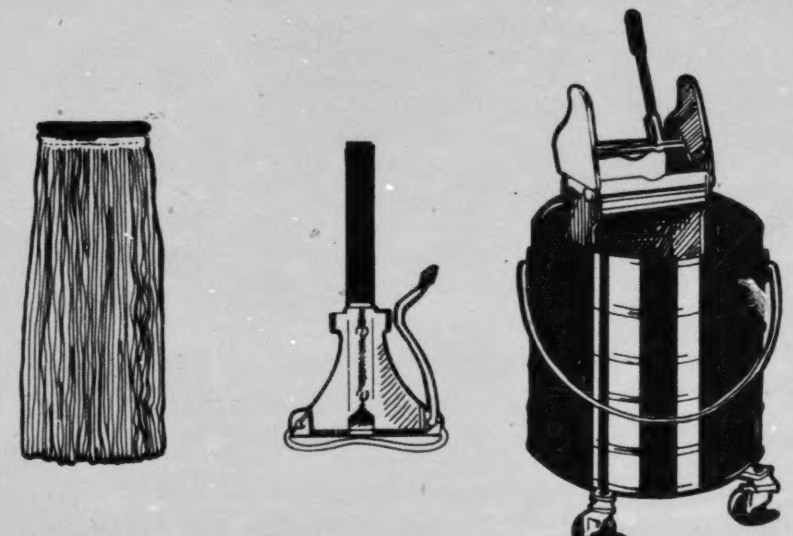


FIGURE 5—Typical mop and mop head and a gear press mop unit.

assigned area. This is periodic work, but some should be accomplished daily, weekly, or on a schedule. Use a *mild* solution of all-purpose cleaner and water to wash the furniture (if furniture wax cannot be used as a cleaner). The waxing procedure depends upon which type of wax is used.

1) Liquid wax (follow instructions on the container). Shake the wax in the container before using. Wet a pad of cheesecloth thoroughly with the wax. Wipe over the entire surface to be treated, using straight-line movements rather than circular movements; keep the cloth well soaked with wax. Let the wax dry thoroughly. Wipe off the haze with a clean pad of cloth, turning the pad often.
2) Wax in aerosol can (follow instructions on the can). Shake can vigorously, holding spray nozzle away from you. Spray directly onto the surface to be waxed, holding can as nearly upright as possible. Wipe with a clean piece of cloth. Caution: Make sure that none of the wax falls on the floor, because it makes the floor dangerously slippery.

Care and storage: All items used in waxing furniture should be cleaned and neatly stored in a locked custodial storage area.

8. FLOOR MAINTENANCE

A floor maintenance crew normally consists of two people. Average daily work production standard for a crew (two persons) is 2,000 to 4,000 gross square feet. (Square feet of work production depends on many things, including traffic congestion and the amount of furniture that has to be moved about.) Each crew member should be expected to use initiative and work management techniques to achieve optimum productivity. Each crew should record its work on a Daily Work Report Card. (See page 115 in the Management Tools Appendix.)

Frequency: As needed

Equipment and supplies: Abrasive synthetic pads (various grades), cleaner, power scrubber, battery charger, cotton mop, counter brush, dust pan, floor finishes, floor machine, floor renovator, floor sealers, linen mop, liquid detergent for power scrubber, mop units, putty knife, wax stripper, water vacuum, and brushes for floor machine or power scrubber.

General procedures: Observe the condition of the finish and the floor. Unless specific instructions have been received, decide on which method of cleaning and refinishing to use. Remember to have the proper equipment and supplies in the correct amount and condition at the proper place and at the right time.

Procedures for soft floors (asphalt tile, rubber tile, vinyl tile, linoleum, etc.):

1) If condition of floor finish is good to fair (light soil, few worn areas), machine clean with abrasive pad, water and finish, or mild solution of all-purpose cleaner; refinish.
2) If condition of floor finish is poor (heavy soil, numerous worn areas), clean with solution of wax stripper or all-purpose cleaner; renovate or seal; refinish.
3) If condition of floor finish is very bad (very heavy soil, floor is devoid of finish or has severely worn areas and/or finish build-up), clean with wax stripper or all purpose cleaner; renovate and seal; refinish.

Refinishing soft floors: Here are some general suggestions; see your chemical supplier for more specific details. Some of the following steps may not be necessary, however, depending upon the method used.

1) Move all furniture and dry clean floor with brush and/or dust mop.
2) Clean the floor using one of the three following methods:
   - Routine scrub with floor machine. Using a water mop, wet down a small area in front of the floor machine so that cleaning solution remains on the floor less than a minute. Cleansing solution may be all-purpose cleaner or wax stripper. If a heavy solution of all-purpose cleaner or wax stripper is used, rinsing may be necessary. An abrasive pad is used under the machine. Clean and reuse the abrasive pads. Use a putty knife to remove gum, etc. (Avoid damaging the floor covering.)
   - Heavy scrub with floor machine. Using a water mop, cover the area with an appropriate amount of cleaning solution. Use a floor machine with scrub brush or abrasive pad to scrub. Use a wet-dry vacuum machine or wet mop to pick up water. Rinse the floor with clear water. Pick up rinse water. *This method may be used on soft floors requiring sealing*

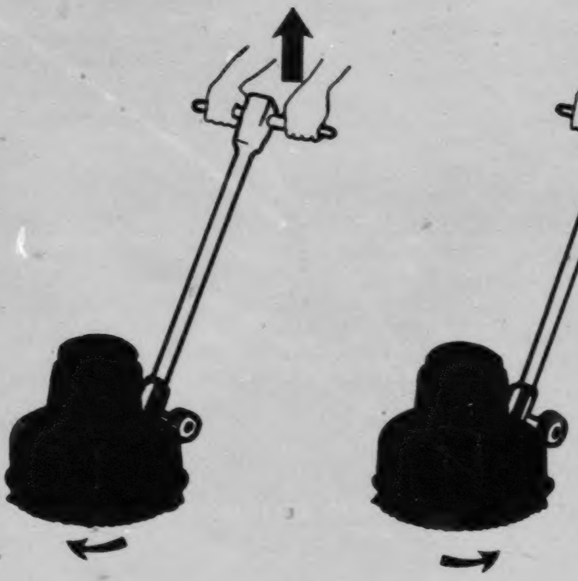


FIGURE 6—A floor machine is used for wet scrubbing. Raise handle to move machine right; lower handle to move left.

or other special attention; however, remove water as soon as possible from soft floors. (Do not let water run under furniture, such as file cabinets.)

- Water mop method. In lightly or moderately soiled areas, water mop the floor using a very mild solution of all-purpose cleaner. Pick up excess solution. Rinse if required. Permit the floor to dry and apply one coat of finish.

3) After floor machine method (routine), use a clean abrasive pad and buff the area that was cleaned (this is called "backing off"). Clean edges with "foot pad" (center of abrasive pad).
4) Dry mop floor area.
5) Apply one coat of finish and let dry. If necessary, apply second coat of finish and let dry.
6) Clean any spattered baseboards or furniture.
7) Buff only if absolutely necessary, or if the floor is in a "prestige" area.
8) Replace furniture.

Sealing soft floors:

1) Move light furniture and dry mop floor.
2) Use floor machine method to scrub floor; let dry.
3) Apply seal with short strand mop; let dry. Apply second coat of seal, if necessary; let dry.

Sealing hard floors:

1) Move furniture and dry mop floor.
2) Scrub floor with water mop method, using a heavy solution of all-purpose cleaner.
3) Pick up cleaning solution with water mop or wet-dry vacuum machine.
4) Rinse and pick up with water mop or wet-dry vacuum machine; let floor dry.
5) Apply seal to floor and use floor machine and brush to work it into the floor; let seal dry. Apply second coat, if necessary, and let dry.
6) If necessary, use floor machine with fiber or polish brush to buff the seal on the following day.
7) Apply finish after seal is dry.

Helpful hints: Rotate the various jobs so that each crew member shares in the work. During periods in which other work cannot be performed, clean abrasive pads and other equipment and, if possible, prepare other areas for floor work.

Develop a work pattern and remember that the pattern varies with different areas.

Always spread a thin coat of finish. Stay some twelve inches from the baseboard unless the floor has been stripped. Swing the mop containing the finish as in wet mopping, but overlap the strokes for even coverage. Avoid streaking. Let the first coat of finish dry before applying the second coat. Fans may help during periods of high humidity. Clean spattered baseboards and furniture.

Overall work performance and professionalism depends on the attention given to details. Clean and well-maintained equipment is important and indicates that pride is taken in the work.

Care and storage: Clean and properly store all equipment and supplies in a secure storage area.

Power scrubbers: The procedure used to refinish floors with a power scrubber is the same as with a regular floor machine, except that the power scrubber is best used in large open areas.

1) To operate the power scrubber:
   - Check the following: battery connections (if battery operated), squeegee, brush, and the solution and recovery tanks.
   - Fill the solution tank with a liquid detergent-water mixture.
   - With machine moving, turn on power and water, lower the brush and squeegee into operating position. Proceed down the right side of the area to be cleaned for approximately six to eight feet before turning machine. Shut off water, make the turn, turn water back on. Proceed in an orderly manner until the entire area has been scrubbed. If problems are encountered, call the vendor who supplied the machine for operating instructions.
2) To clean and store the power scrubber:
   - At the end of each daily use, empty and clean the tanks; check and clean the filter if needed.
   - Clean battery connections with a mild solution of ammonia (or soda) and water.
   - Wash exterior parts with a mild solution of detergent and water.
   - Clean squeegee by running a piece of folded cheesecloth along the bottom edge.
   - Check and rinse the hoses periodically.
   - Check the gearbox and chains monthly and lubricate as needed.
   - Charge batteries after each use (if battery operated).
   - Store in a clean, dry area with squeegee and brushes in the up position.

9. INTERIOR GLASS CLEANING

Window glass cleaner may be used to clean interior glass.

Frequency: Entrance door glass is cleaned daily inside and out. Partitions, transom, interior door glass, baffle glass, and glass top desks are cleaned as needed.

Equipment: Cheesecloth and glass cleaner.

Procedure: Apply a little cleaner to the glass using a vertical spraying motion; then use a cloth pad to spread it over the rest of the glass area. Rub the glass with the cloth pad (or paper towel) until the cleaner dries. Normally, it takes only a few seconds to clean an average glass door, desk top, etc., when the cleaner is properly used. Avoid using too much glass cleaner since it takes longer.

10. WINDOW WASHING

Typically, custodians work in teams to wash exterior windows and clean venetian blinds.

Frequency: In Illinois, a typical standard for window cleaning is two washings each year, inside and out. If special conditions exist, more frequent cleaning may be required. Venetian blinds are dusted and washed as needed. Screens and storm windows are usually cleaned once a year.

Equipment for cleaning windows: Ammonia, buckets, cloth pads, detergent pellets, hose, ladders (straight and step), metal box, window cleaning telescoping pole with hose and brushes, sponges, squeegees (6, 10, or 14 inch), window belts, and window cleaner.

Equipment for cleaning screens: Hose, pistol grip nozzle, and plastic bristle broom.

Procedure for interior window washing:

1) Arrange equipment and prepare supplies for work. If necessary, advise room occupants concerning work to be accomplished.
2) Raise venetian blinds or shades and remove all items from window sills. Avoid marring of the window sills.
3) Use sponge and water (with or without cleaner) and wash glass. Use left-to-right and up-and-down, overlapping strokes to clean the entire glass surface. Use stepladder to clean upper sash first.
4) Do not stand on radiators, desks, fans, chairs, etc. Never work from a higher posi-

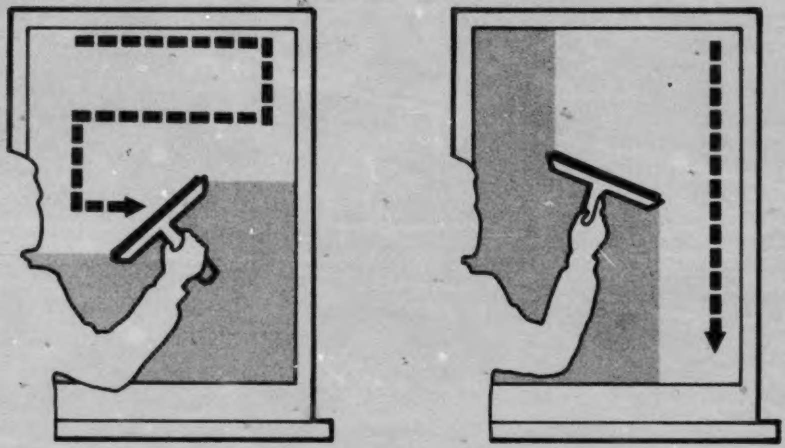


FIGURE 7—Efficient squeegee motions make water run toward trailing edge and away from cleaned area.

tion than the second step from the top of a stepladder.

5) Use squeegee to remove water. There are two basic squeegee motions, side to side and top to bottom. (See Figure 7) Either motion is acceptable. In the side-to-side method, make one continuous stroke. Start with the squeegee in a vertical position at an upper corner of the window, stroke across, and when reaching the opposite side, make a simple half turn and return. Continue back and forth in overlapping strokes. Excess water will collect in the lower corner of the window. When using the top-to-bottom method, move the squeegee in separate strokes. The blade of the squeegee should be wiped with a sponge or cloth pad after each stroke.
6) Use sponge or cloth pad to wipe up water.
7) Check work and then replace items on window sills. Leave blind or shade in the position you found it.

Procedures for exterior window washing:

1) The safety belt method.
   - Arrange equipment and prepare supplies. Inspect safety belt. Check buckle, ropes, and hooks to be sure that all are in proper working order.
   - Put safety belt on and adjust the belt by holding a hook in each hand and stretching your arms outward until your hands are about shoulder height. Check the rope for proper length.
   - For going outside double hung windows and returning inside (See Figure 8): Fully open lower window sash. Sit on the window sill with both legs inside and hold onto sill with one hand. Inspect all of the window bolts to see that they are anchored and undamaged. Use one hand and hold onto lower portion of window sash and use the other hand to hook the terminal of one side of the safety belt rope to the adjacent window bolt. Check hook-up by pulling on the anchored end of the belt. Cautiously rise to a standing position while holding the anchored side of the rope with one hand and the bottom part of the window sash with the other hand. After balance is attained, move the hand from the anchored rope to the bottom of the sash and use the other hand to hook-up the other end of the rope to the other window bolt. Check this hook-up. Lower the raised window sash. Use sponge and water, with or without cleaner, and wash glass, starting with the upper sash. After performing all cleaning (glass, framework, and sill), prepare to go back inside. Fully open lower window sash. Use one hand to hold onto the bottom of the window sash while using the other hand to unhook one end of rope from the window bolt. After one end is unhooked, sit down on window sill with both legs inside. Use one hand to hold onto window sill and use other hand to unhook the second end of the rope from the window bolt. After

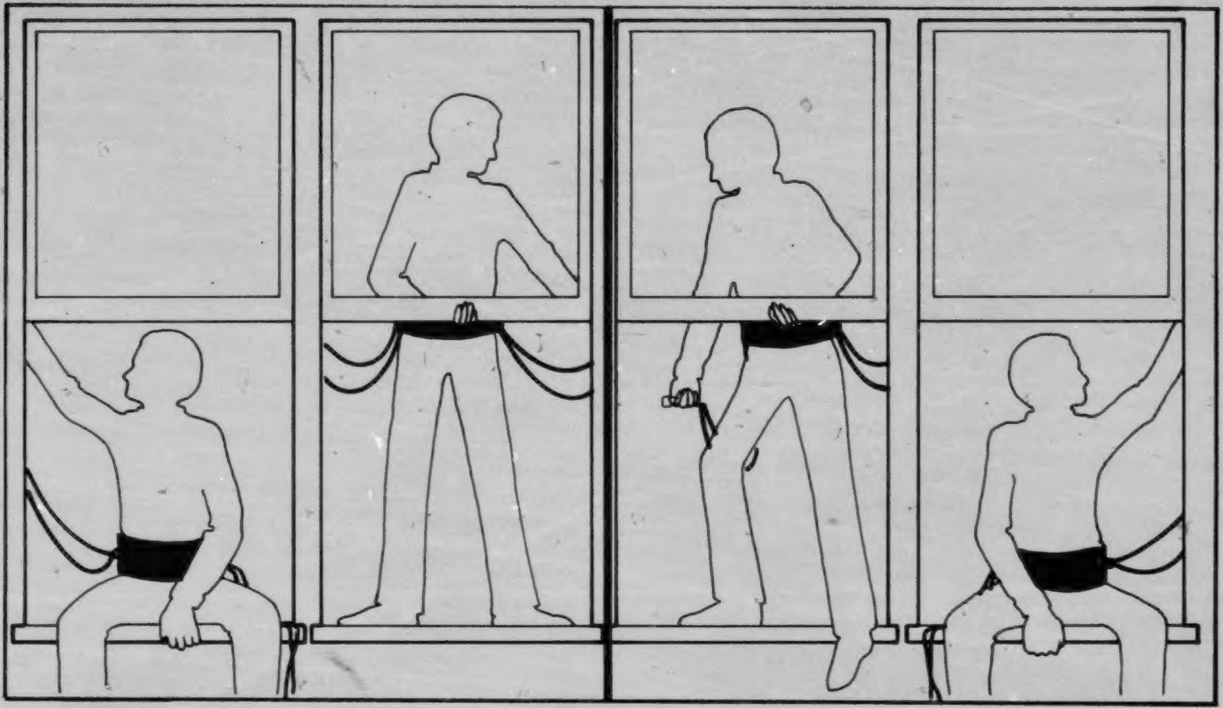


FIGURE 8—To ensure safety, proper procedures must be followed when going outside of a double hung window (left) and re-entering (right) after cleaning.

second terminal is unhooked, come inside and close the window.

2) The pole washing method:
   - This window washing procedure is used to clean watertight windows which are some 50 feet or less above ground.
   - Arrange equipment and prepare supplies for work. Use up to five people and two pole window washing units. Two people operate one unit and wash. Two people operate the second unit and rinse. The fifth person is inside closing windows, drying up water that seeps in, and checking the work.

3) Other methods: On buildings where windows are 50 feet or more above ground level, scaffolding is one method employed for such work. Tubular or swinging scaffold may be used. There are occasional situations where ladders are used.

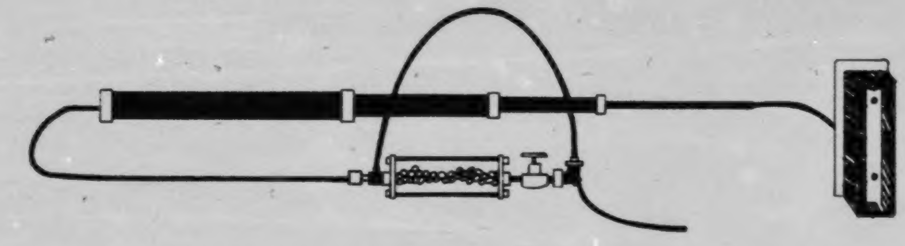


FIGURE 9—Window washing pole unit can be connected directly to a water supply and equipped with a canister of cleaning pellets.

TYPICAL SUPPLIES AND EQUIPMENT FOR GENERAL BUILDING MAINTENANCE

ABRASIVE CLEANER

General: Abrasive cleaner is usually packaged in cans.

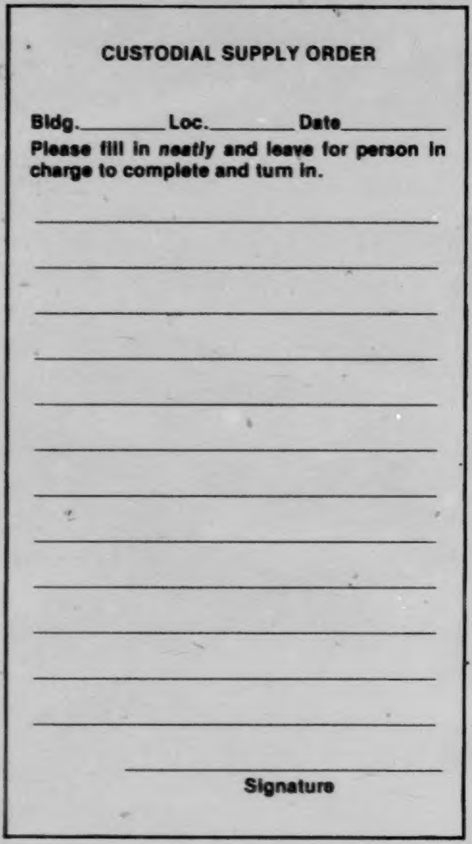
Use: Abrasive cleaner is used when necessary to remove stubborn soil or stains on drinking fountains, toilet fixtures, floors (hard), glazed wall surfaces, and formica. When improperly used, abrasive cleaner roughens the finish and makes cleaning more difficult. After abrasive cleaner is used, the area should be thoroughly rinsed and wiped dry. Abrasive cleaner should not be used in any daily cleaning procedure unless there is no other way to do it.

Care and storage: Abrasive cleaner should be stored on shelves in a dry, secure custodial storage area.

ALL-PURPOSE CLEANER (APC)

General: All-purpose cleaner (APC) is usually a detergent in either powder or liquid form. Specific manufacturer's instructions are distributed when there is a change from one product to the other. Most APCs used are powerful, and the use of too much can cause damage. Check with your supervisor before using extra amounts of APC. The addition of any other cleaning agent to the chemically balanced detergent tends to destroy its cleaning power. If there is a question, check the containers for use instructions.

Use: APC may be used for the following: Water mopping floors, cleaning floors for re-



CUSTODIAL SUPPLY ORDER

Bldg.________ Loc.________ Date__________

Please fill in *neatly* and leave for person in charge to complete and turn in.

Signature

FIGURE 10—Form for ordering custodial supplies.

finishing, daily cleaning of toilet fixtures and drinking fountains, spot cleaning, and cleaning furniture.

Care and storage: Liquid APCs are normally received in cans. Powder APC is shipped in airtight containers. All APCs should be stored in a locked, dry, storage area.

Caution: Never add anything but water to a cleaning mixture of APC.

AMMONIA

Use: Ammonia (two to three tablespoons per gallon of water) is used to clean glass.

Care and storage: After use, clean the outside of the bottle and store it in a locked storage area.

Caution: Ammonia is a poison. Avoid inhalation of ammonia fumes.

BOWL CLEANER APPLICATOR

Use: The applicator is used with liquid bowl cleaner when cleaning stools and urinals. Full-strength bowl cleaner or all-purpose cleaner is applied directly on the applicator (avoid dripping on floors). All rims, grooves, and inside surfaces are then scrubbed with the applicator. The applicator may be used to lower the water level prior to cleaning.

Care and storage: After use, rinse out the applicator, squeeze out excess water, and hang it to dry on a custodial cart in the storage area.

FIGURE 11—Typical acrilan swab.

BOWL CLEANER — LIQUID

Use: Liquid bowl cleaners contain acid and must be used carefully to avoid injury to person or property or both. Under normal conditions, the frequency of use is once a week. Liquid bowl cleaner is used to clean vitreous china toilet bowls and urinals only.

Care and storage: Supplies of bowl cleaner must be stored on a bottom shelf in the storage area for reasons of safety.

Caution: Do not mix bowl cleaner with any other cleaner. Handle this material carefully and avoid either contact with skin or prolonged inhalation of fumes.

BROOMS

General: Brooms are made from cornstraw, equipped with splinter-free wooden handles, and sewn with good quality twine.

Use: Brooms are used to clean rough floors, porches, and, if necessary, wet areas.

Care and storage: Clean and store brooms in a rack in the locked custodial storage area so that no weight or pressure is on the straw.

CUSTODIAL CARTS

Types: Custodial cart, utility can on casters, utility can, and four-wheeled platform truck.

General: Custodial carts are used to transport waste from the various areas within the building to the trash collection area. Most carts are equipped with shelves for carrying supplies and equipment, which tends to reduce unproductive time.

Use: The custodial cart has a detachable utility can for waste and several shelves for storage of supplies and equipment. Some models have broom or mop holders and may be equipped with hooks for equipment.

The utility can on casters is a lightweight waste container which may be equipped with a half-moon basket for supplies which fits inside the container. Hooks for equipment may be installed on the sides of the utility can. Casters may be used.

Utility cans are used for collecting waste in congested areas in buildings without elevators. They can be carried up and down stairs.

The four-wheeled platform trucks with one or two 55-gallon metal drums are used to collect waste in laboratories. They may or may not be equipped with shelves for carrying tools and supplies.

Care and storage: All custodial cart waste containers should be emptied at the end of each day's use. Each custodian is responsible for the cleanliness and maintenance of his or her cart. All carts are stored in locked storage areas.

CHALK AND ERASERS

General: The white chalk may be a dustless blackboard crayon. The eraser might be a double-sewed, felt-type, blackboard eraser.

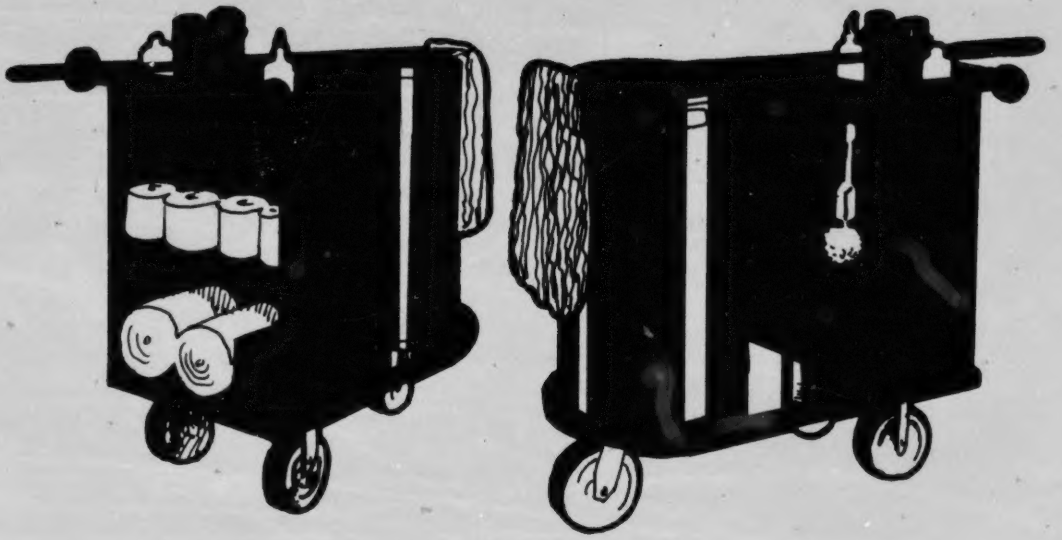


FIGURE 12—Service carts carry supplies and waste receptacles.

Use: Chalk and erasers are furnished for all blackboards. Two or three long pieces of chalk and one eraser are provided for each three-to-four-foot section of blackboard unless otherwise directed.

Care and storage: Small supplies of these items are carried on the custodial cart. Larger supplies of chalk and erasers should be neatly stored on the shelves in the locked storage area. Extra supplies may be left with the teachers.

CHEESECLOTH OR CLOTH PADS

General: Cheesecloth is packaged in 70-yard bolts, and cloth pads are available in various packaging.

Use: Cheesecloth or cloth pads are used for numerous cleaning operations. Approximately one yard of cheesecloth makes a good pad which can be used in any number of ways: Cleaning and drying of drinking fountains, toilet fixtures, mirrors, glass surfaces, etc.; washing and waxing furniture; spot cleaning painted walls, partitions, and doors; damp wiping ash trays; cleaning toilet seats. A small pad of cheesecloth or cloth pad can be carried in your pocket at all times for quick dry dusting.

Care and storage: Bolts of cheesecloth or boxes of cloth pads should be stored on a shelf in the locked storage area. Used cheesecloth or cloth pads may be rinsed clean and hung up to dry in the storage area, then reused.

COUNTER BRUSH

General: An eight-inch, soft, black horsehair, staple-set bench brush, or its equivalent, is an acceptable counter brush. All handles should have a hole or screw eye for hanging the brush on the custodial cart.

Use: The counter brush is used with a dust pan to pick up soil accumulations. The counter brush is also used to clean soil from hard-to-get areas.

Care and storage: Clean the counter brush bristles with the edge of a dust pan and hang it on the custodial cart.

DOOR MATS

General: There are many types of mats: Link rubber entrance mats; corded rubber mats; and carpet walk-off mats. Corded rubber mats are used inside the entrances of buildings. Walk-off mats are used inside the entrances of buildings. They are available in various sizes. The carpet-type mats are vacuumed periodically and should be thoroughly scrubbed as needed.

Use: Door mats provide building occupants a

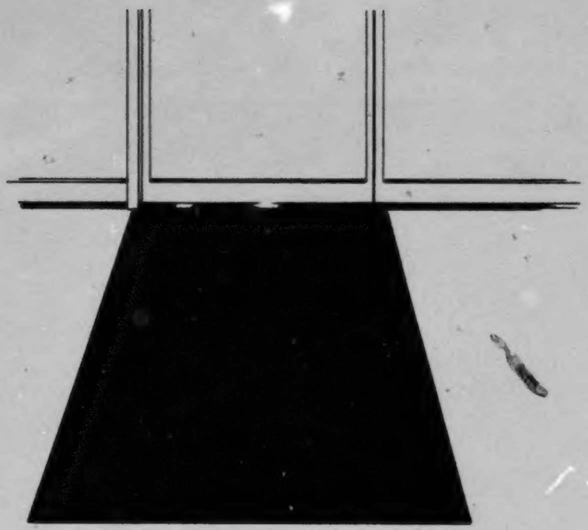


FIGURE 13—Carpet entrance mat catches dirt before it can be tracked further into the building.

place to remove dirt and water from their shoes.

Care and storage: All door mats are kept in locked storage areas when not in use. Custodians are responsible for the care, cleaning, and storage of door mats. Surfaces under recessed mats are cleaned as needed or at least once a month.

DUST PAN

General: The dust pan is constructed of one-piece steel, painted with black enamel.

Use: The dust pan and the counter brush are used to pick up soil accumulation. Hang the dust pan on the custodial cart for convenience.

Care and storage: After use, clean the soil from the dust pan and hang it on the custodial cart which is stored in the locked custodial storage area.

FLOOR BRUSH

General: Push brooms or floor brushes are available in many widths. The width used depends on the area to be cleaned.

Use: Push brooms are used on rough floors for removal of heavy dry soil. Select the proper width of brush and length of handle to reduce fatigue and maintain the number of strokes. Sweeping compound should be used *only* on hard floors where dust control is necessary.

Care and storage: Clean and store the broom in a broom rack in the locked storage area so that no weight or pressure is on the bristles. Never store brooms near heat pipes or radiators. Comb the bristles as needed.

Caution: Do not use a push broom to sweep wet floor areas unless it is made with synthetic bristles.

FLOOR MACHINES

General: Floor machines are available in many brands and sizes. Select the proper size for the area to be serviced. Normally, a 17-inch to 19-inch machine is used in schools.

Use: Floor machines are used to refinish soft and hard floors.

Care and storage: After use, clean the machine and store in the locked storage area. Prior to using, check machine and electrical cord for needed repairs.

FUNNELS

General: One pint plastic or metal funnels are acceptable.

Use: Funnels are used to transfer liquids from one container to another. Avoid unnecessary spillage. Always clean all spillage.

Care and storage: After use, clean and store the funnel in the locked storage area.

Caution: Do not use a metal funnel for acid-type cleaners.

FURNITURE POLISH

General: Many types of furniture polishes are used. They are available in one-quart containers, pressurized aerosol cans, etc.

Use: Furniture polishes are used to clean and restore the surfaces of various types of furniture. Always follow the use instructions printed on the container label. (Also check the waxing instructions received with the furniture for the best product to use.)

Care and storage: After use, clean the spillage from the outside surface of the container and store in the locked custodial storage area.

GEAR PRESS-TYPE MOP UNITS

General: Several gear press-type mop units are available in different sizes. One is the 16-quart mop pail and downward pressure wringer. The second is a 32-quart mop unit. Both units are equipped with casters. The 16-quart units may be used in congested areas, and the 32-quart units may be used in larger areas.

Use: Gear press-type mop units are used daily as part of the equipment required in wet mopping. With the 32-quart unit, fill the pail with three to four gallons of water, and in the 16-quart unit fill the pail with one and one-half to two gallons of water. Wherever possible, obtain the water from a service sink and empty the waste water into a service sink.

Care and storage: After use, rinse and wipe out the pail and store it upside down in the locked custodial storage area. Clean and store the wringer. Clean outside surfaces of the pail as needed.

GLASS CLEANER

General: Window cleaner is used for door glass, glass desk tops, etc.

Use: Window glass cleaner is used to clean all types of inside glass, such as display case glass, glass desk tops, and bookcases.

Care and storage: Glass cleaner is stored in locked storage areas. It is the responsibility of the custodian to keep the inside and outside of the glass cleaner containers clean.

HAND DUSTER

General: A preferred hand duster is normally 24 inches long and has a strong, rigid wire frame and a hardwood handle. The wooden handle must have an eyelet or quarter-inch hole for hanging. The duster head is cotton yarn, double stitched to sanforized canvas or a similar synthetic material.

Use: The cotton duster head is treated with a dust controllant. Properly used, the hand duster picks up dust and does not transfer it from one place to another. Most horizontal and vertical surface dusting is done with the hand duster.

Care and storage: Hang the duster on the custodial cart and store it in the locked storage area. When the duster no longer holds dust, remove the handle and place the duster in a designated area provided for pickup and laundering. Newly-laundered and treated duster heads should be neatly stacked on the shelves in the storage room. Do not remove the plastic covering from the duster until ready to use. Since treatment dries out, always use the duster received first and never overstock the supply in the storage area.

METAL POLISH

General: Metal polish is normally packaged in pint containers.

Use: The container of metal polish should be shaken well before use. Put a little polish on a damp pad of cloth or a damp paper towel. When stains or tarnish are removed, permit the polish to dry. Then polish with a clean pad of cloth. Most metal polish may be used on copper, pewter, silver, brass, aluminum, nickel, bronze, tin, and zinc. However, check use instructions on the container before using. Normally, metal cleaning is a periodic procedure.

Care and storage: The can of metal polish may be stored on the custodial cart or on the shelves in a locked storage area. The outside and top of all containers of metal polish should be clean at all times.

MOPS, MOPSTICKS, MOP HEADS

General: There are many types of mops which are commonly used in school cleaning operations. They are: mopstick with cotton mop head; dust mop; wedge mop; etc.

Use: Mopsticks with cotton mop heads are used for wet and dry cleaning. However, mops specially treated and used for dry cleaning are never used for wet mopping. Mop heads are made from white cotton stock bound with fabric tape which is securely sewn with lock or chain stitching. The handle must have a smooth finish. Never permit the treated mop to stand on any floor surface. Wedge mops are used for dry mopping in congested areas and on stair steps. They are also used for overhead dusting. These mops are normally treated with a water base dust controllant.

Care and storage: Before and after work periods, thoroughly shake mops to remove any dirt. Inspect mops after each work period. Handles should be smooth and free of splinters. Broken handles should be exchanged for new ones. Mop heads treated with water base dust controllants tend to dry out in storage; they should never be kept longer than two weeks, even though they are packaged. Soiled mop heads which have been treated with water base dust controllants are gathered together and placed in an assigned area for pickup and laundering.

OIL DRY

General: Oil dry is distributed in bags.

Use: Oil dry is used in shops, garages, or other areas where oil drippings are a problem. The oil drippings are sprinkled with oil dry which absorbs the oil; then the saturated oil dry is cleaned up.

Care and storage: Oil dry is stored in a dry location in locked storage areas. Clean any spillage promptly.

PAILS

Use: Twelve-quart pails are used in many cleaning procedures. Among these are: Cleaning blackboards, washing and waxing furniture, and spot cleaning.

Care and Storage: Thoroughly rinse the pail before storing it in the locked storage area. Never place an acid-type product in a galvanized pail as the pail may be damaged.

PLUMBER'S FRIEND

General: The plumber's friend is equipped with a six-inch black tom plumber's force cup.

Use: A plumber's friend is used to unplug drains in lavatories, urinals, and stools. Set the cup over the drain hole like a stopper. Push down on the handle to flatten the cup. Then pull the plunger out quickly. Use a wet paper towel or pad of cheesecloth to temporarily seal off the air vent of lavatories. Do this several times to loosen the material that is stopping the drain. If the drain is still plugged, report it according to local instructions.

Care and storage: After use, clean the plumber's friend and store it in the locked storage area.

POWER SCRUBBERS

General: At least two types of power scrubbers are available: a battery-powered, self-propelled machine with portable battery charger and a 110-volt portable electric machine.

FIGURE 14—Here is a battery-powered automatic scrubber. Others operate on 100 volt AC current.

Use: These machines are used in large open areas for scrubbing and cleaning operations.

Care and storage: Operators should clean and drain the tanks of each machine prior to storage. Only well-ventilated areas are to be used while charging the battery-powered machines.

POWER SWEEPERS

General: Gasoline powered, self-propelled power sweepers are used for sweeping large open areas.

Care and storage: After each use, the machine's dirt catching hopper should be emptied, the filter cleaned, and oil checked. Periodic maintenance is accomplished as directed by the manufacturer.

PRODUCTS FOR DRY MOP TREATMENT

General: Aromatic liquid chemical is used as a neutral floor dressing treatment for cotton strand dust mops. The chemical aids in the collection of dust and loose dirt from sealed, finished, or waxed floors of all types.

Use: A chemical treatment is used to prepare the dust mop for daily use. Amounts used vary with floor type and condition. A mop may be refurbished periodically by sprinkling a few ounces of treatment on the mop head to keep it from drying out. If a newly-treated mop leaves streaks on the floor, it is not ready for use and should be allowed to "cure" longer. When the newly-treated mop leaves dust on the floor, it does not contain enough dust control treatment and it should be lightly sprinkled with treatment and be permitted to stand overnight. Treatment should spread outward from the center of the mop head.

Care and storage: After use, clean the outside of the can containing mop treatment and store it in the locked storage area. Never store treated dry mop or mop treatment near hot pipes.

Caution: Excessive use of treatment on mops may damage soft floors. Some mop treatments are flammable; avoid their use.

PUTTY KNIFE

General: A one-inch elastic putty knife is used.

Use: A putty knife is used to remove gum and other sticky soil from floors. Gently pry the soil loose, using care not to mar the floor covering.

Care and storage: The putty knife may be kept in the custodial cart or in the locked storage area.

RADIATOR BRUSH

General: The radiator brush has a wooden or metal handle approximately 30 inches long and over one-half inch thick.

Use: The radiator brush is used to clean between the coils, behind and under the radiators.

Care and storage: Hang radiator brush on the custodial cart.

FIGURE 15—Typical radiator brush.

SCRUB BRUSH

General: A knob scrub brush is made with palmetto fiber and equipped with a handle.

Use: The scrub brush is used primarily in the periodic cleaning of the interior and deck areas of swimming pools. Scrub brushes are often used in areas where floor machines are unable to perform the cleaning.

Care and storage: After use, thoroughly rinse the scrub brush and store it in the locked storage area. The weight of the brush should not be resting on the bristles.

SPONGES

Types: Natural sponges and cellulose sponges.

General: Sponges are expensive and the custodian must make every effort to obtain maximum use from each sponge.

Use: Large sponges may be used to wash blackboards; smaller sponges are used to spot clean, etc.

Care and storage: When work is completed, wash out the sponge and store it in the locked storage area. Store the sponge so that it will dry.

SPRAY-WIPE CLEANER

General: Spray-wipe cleaner is packaged in aerosol cans. This product should be used according to instructions printed on the label.

Use: Spray-wipe cleaner is good for cleaning fixtures and for spot cleaning.

Care and storage: Store away from heat or steam pipes in a locked storage area.

SQUEEGEE

General: Window squeegees are available in several sizes: 8, 10, 14, and 18 inches. Rubber refills may be purchased in three foot lengths and cut to size.

Use: Squeegees are used to clean glass, blackboards, and windows.

Care and storage: Wipe dry and inspect the blade of the squeegee after each use; replace the blade as needed. Store the squeegee on a hook in the locked storage area so that its weight is not on the rubber blade.

STEPLADDERS

General: Several sizes of heavy duty, rung-back, safety platform ladders are available. Based on the need, obtain a proper size.

Use: Place the stepladder in a secure position and test it before performing any work from it. In using a stepladder, always maintain a stable position. Never perform work from the top step of any stepladder.

Care and storage: After use, store the stepladder in the locked storage area. Clean the ladder as needed so that it always has a neat appearance. Before each use, check it for safety.

STREET BROOMS

General: Heavy duty street brooms with extra heavy, hardwood handles are best.

Use: Street brooms are used to clean machine shop floors made of wooden blocks. They are also used to clean rough floors, ramps, etc.

Care and storage: Clean and store the broom in a broom rack in the locked storage area so that no weight or pressure is on the fibers. Reverse handle periodically to promote even wear.

TOILET SUPPLIES

Items: Sanitary bags, wax bags, toilet paper, and toilet soap.

General: Toilet supplies are checked and replenished as needed. Install at least two toilet paper holders in each stall so extra paper is available. Soap is placed in the dispenser provided.

Use: Wax bags are used in sanitary napkin receptacles. If they contain any waste, they are removed each day and the receptacle is relined with a new bag. Sanitary bags are placed on the back of the door (or other suitable area) of each stall with a stool in all women's toilets. Toilet paper is used in toilets of school buildings. Toilet soap-liquid is normally available in one or five gallon containers. Toilet soap-granular is ordered by the pound.

Care and storage: All toilet supplies are stored with care in the locked storage areas so that items do not become soiled. All dry toilet supplies are to be stored on the upper shelves of the storage area in order to avoid damage by leakage or accidental spillage of liquid supplies.

TOWEL CABINETS

Types: Cloth, folded paper, and rolled paper.

General: Towel cabinets are used in all toilet areas. The custodian is responsible for periodic service checks to replenish the towel supply in the cabinets. If a towel cabinet fails to operate, it should be repaired or reported, stating the exact location, cabinet number, type of towel cabinet, and the failing part, if possible.

Use: Cloth towel cabinets use roller towels about 150 feet long and 12 inches wide, with 225 individual drying spaces. For cabinet operation, see the instructions on the inside of each cabinet. Paper towel cabinets may be used in toilets, laboratories, etc. Soiled paper towels are placed in a waste container which is emptied daily or as needed. Roller paper towel cabinets also may be used in schools. Soiled paper towels are placed in a waste container which is emptied daily or as needed.

Care and storage: Supplies of towels are neatly arranged in the locked storage area. Soiled cloth towels are stored separately from clean cloth towels in the storage area. All towel cabinets are dusted daily and spot cleaned as needed.

VACUUM CLEANERS

Types: Wet-dry vacuum cleaners, upright brush-type dry vacuum cleaners, and tank-type dry vacuum cleaners.

General: Custodians use vacuum cleaners to remove soil. All rugs or carpets should be vacuumed as needed. Regular vacuuming increases the life of the rug by removing sharp, gritty particles that grind the fibers of the rug.

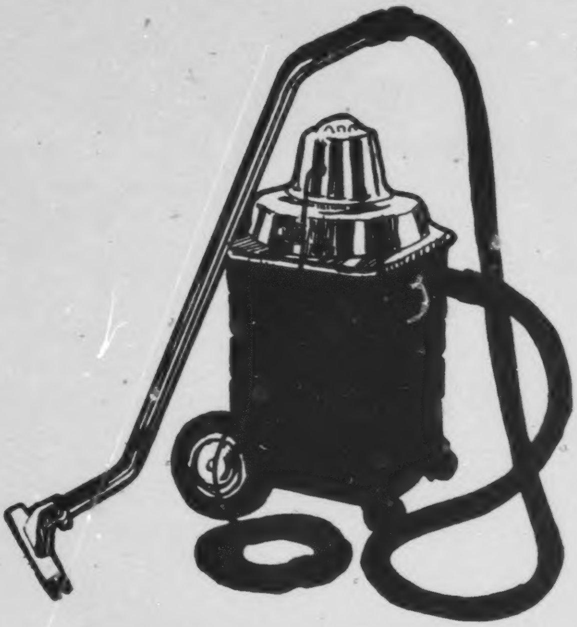


FIGURE 16—Wet-dry vacuum cleaner picks up liquids, such as in wet mopping.

Use: Vacuum cleaners are used to remove soil from floor areas which are, for the most part, carpeted. Each vacuum cleaner has several parts, such as a hose, wand, cleaning tools, etc., and the custodian must know their use. The quantity of soil removed is proportional to the length of time the vacuum cleaner (in proper working order) is used on the area to be cleaned. Wet-dry vacuum cleaners are used to remove liquids from floors, such as in wet mopping or floods. Upright brush-type vacuum cleaners are part of the custodial equipment in any school building with rugs or carpets. Tank-type dry vacuum cleaners are used for dust removal, etc. A dry vacuum cleaner should *not* be used to remove liquids.

Care and storage: The custodian using the vacuum equipment is responsible for its proper care, cleaning, and storage. Repairs needed are reported to the supervisor. All vacuum equipment is stored in the locked storage area.

WASTEBASKETS

General: Several sizes and types of wastebaskets are used in schools.

Use: Building occupants deposit waste in wastebaskets. Custodians empty these wastebaskets. Locate wastebaskets in an area where they will be used. (In a classroom this may be near the door. Normally, one per classroom is sufficient.)

Caution: In resetting the empty wastebasket, avoid striking furniture and walls.

Exterior Building Care

Timely cleaning and repair of exterior building surfaces and components extend useful building life. As in maintaining all physical plant property, careful scheduling and record keeping are necessary to keep buildings looking well-kept and to avoid damaging deterioration by correcting small problems before they become large ones.

Develop check lists for each building to guide inspection procedures. The aim should be to find and record visible defects and to repair them as promptly as possible.

A work schedule should be developed to aid in scheduling and assigning jobs and should be coordinated with the Annual Building Inspection Check Lists provided in the Management Tools Appendix on pages 131 to 136.

Following is a typical schedule for exterior building maintenance that should be satisfactory in most instances. Note that this schedule probably should be coordinated with a grounds maintenance schedule (see Section 3—Grounds Maintenance).

Daily

Raise and lower flag.

Weekly

Sweep walls, drives, and parking areas.

Collect litter at building entries, around planters, and on lawns.

Wash door glass and side lights.

Monthly

Wash windows.

Wash aluminum entrance doors.

Inspect building exterior.

Quarterly

Adjust door hardware.

Lubricate door hinges and locks.

Inspect roofing.

Inspect landscaping.

Annually

Lubricate window hinges.

Inspect sidewalks.

As needed

Replace light bulbs.

Repaint wood trim and sheet metal.

Caulk sash and door frames.

Repaint metal doors and frames.

Remove snow and ice.

Remove debris at storm inlets.

Personnel assigned to exterior building maintenance should be experienced in at least minor maintenance tasks, such as tuckpointing, painting, caulking, and carpentry. Major repair tasks may be more beneficially handled by outside contractors. Inspection and other nonemergency types of work can be scheduled during student vacations and/or holidays.

While some tasks must be repeated regularly, others need be accomplished only as they become necessary, such as repainting of wood and metal surfaces and caulking. Necessity for such tasks can be determined during quarterly or annual inspections or based upon a predetermined cycle (such as arbitrarily repainting wood trim every three or four years or recaulking sash and door frames every five years).

Inspectors of exterior and interior surfaces should be alert to insect infestation. Termites can severely damage untreated wood sills, casework, doors, windows, and trim in a very short time and can attack the building even before completion. If treatment of earth at the building perimeter is not part of the building construction contract, then earth and exposed wood surfaces near grade should be treated by the maintenance forces or contract exterminator as soon as possible after occupancy.

Roofing Care

The "built-up" roof of asphalt or coal tar pitch is one of the few major building components which is "manufactured" at the job site and out in the weather. Life expectancy of the roof depends upon the use of quality materials, assembled in the proper sequence, with good application techniques under proper climatic conditions. Life of the roof also depends upon the prevention or early repair of damage caused by water penetration at edges, flashings, and mechanical penetrations for vents and piping.

"Built-up" roofs should be carefully inspected at least twice a year, preferably in spring and fall in the Midwest. If maintenance personnel are not experienced in roofing inspection and maintenance, they should seek help from a roofing contractor or other qualified individuals.

Use a checklist and small-scale plan view drawing of the roof showing locations of flashings, gutters, downspouts, expansion and control joints, parapets, and roof penetrations. Mark the location of defects on the drawing for reference in planning repairs and specifying work.

The maintenance supervisor should be familiar with the details of all roof guarantees and service agreements. He should see that any emergency repairs or maintenance is done in compliance with the guarantor of bond and that required reports are forwarded to the guaranteeing company.

Careful inspection of flashings, copings, counterflashings, pitch pots, and other mechanical penetrations usually uncovers the cause of most roof leaks. These areas should be checked prior to contacting the roofing contractor, and may require only minor repairs by the maintenance staff.

INSPECTION SCHEDULE

Materials Required

- Tape measure
- Checklist (see Management Tools Appendix on page 131.)
- Small-scale roof plan drawing (Xerox or copy which can be marked up)
- Pocket knife

Spring Inspection

A report should be made of the general appearance of the roof, such as:

- Any visible buckles, ridges, blisters, or bare spots.
- Any gravel blown off; the location and amount of gravel in gutters.
- Any copper counterflashings blown off, where, and how much.

Separate copies of the inspection checklist should be completed for each building or each major roof section of a large building. Remarks should be written in the appropriate section with specific dimensions and locations of defects to provide directions for summer repairs.

Specific defects to look for on spring inspections are: Splits in roof membrane due to temperature changes: cracks in expansion joint materials; open joints in wall copings; loose and missing counterflashings; bare spots in gravel; foreign objects on roof; excessive ponding; ridges.

Clean leaves, dirt, and debris from roof drains so that they drain freely and eliminate ponding.

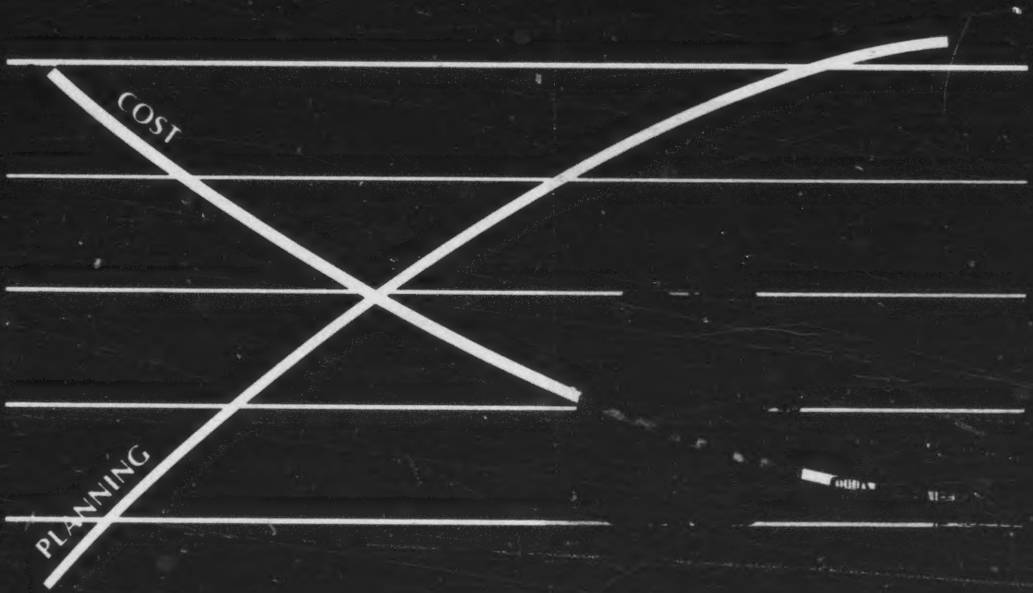
Fall Inspection

The same procedures should be followed for fall inspections, but be more alert to defects caused by summer conditions, such as: blisters in roofing membrane; gravel blown off or washed off; foreign objects on roof; debris in roof drains; etc.

Whether inspections are made twice a year or at irregular intervals, careful records should be kept to indicate the condition of roof flashings, gravel stops, gutters, etc., type and extent of repairs and maintenance, when, where, and by whom. Such information is valuable in appraising the condition of the roof and for diagnosing maintenance problems.

Major Maintenance or Re-Roofing

When planning major maintenance or re-roofing, it is recommended that an architect be consulted regarding compatability of materials, possible changes in roof dead load, energy conservation, and control of dewpoint within the assembly.



Grounds Maintenance

Effective Grounds Management

The first step in managing a grounds maintenance program is to identify all necessary tasks and categorize them into seasonal jobs. A variety of circumstances will limit the amount of work that may be finished; thus, it is essential that priorities be established.

The second step is to devise an efficient combination of men and machines. The third is to develop a schedule that will accomplish the most work in the time available. To eliminate last minute confusion, a scheduled activity should have work areas identified, and equipment should be available and in good working order. Personnel must have a thorough knowledge of job requirements and limits.

Preseason preparation cannot be over-emphasized. Repair parts for equipment must be ordered soon after the using season ends. Rebuilding should be well underway at least two months before needed again. A judicious inventory of spare parts should be on hand to minimize down time. Often, a spare machine is a wise investment to keep production rolling if a breakdown cannot be rectified immediately.

It is advisable to keep track of maintenance costs on each type of machine. If repair costs and down time are excessive, consider changing to a

A SUGGESTED SEASONAL SCHEDULE

SPRING

1) Remove leftover leaves and thoroughly clean up grounds. Pay particular attention to correcting conditions that damage mowing equipment.

2) When grounds can be worked and danger of frost is over, plant spring annuals.

3) Fertilize lawns if soil tests and program dictates need.

4) Spot repair turf areas with sod. Lay no more sod than can be kept watered in summer dry season.

5) Commence mowing grass and trimming hedge when growth appears. If this activity is behind schedule, spring weather may not let work be caught up.

6) Prune early flowering ornamentals after spring bloom is over.

7) Check all hoses and irrigation equipment. Make needed additions and replacements.

8) Identify damage to streets, parking lots, and sidewalks caused by freezing and thawing or general wear and tear as soon as frost leaves the ground. Prepare and contract summer oil and chip program if needed. Develop possible grounds improvement construction projects.

SUMMER

1) Continue broadleaf weed spraying.

2) Inspect newly-sodded areas, trees, and shrubs regularly. Water when rainfall is inadequate. Don't wait too long.

3) Order and schedule delivery for replacement trees for fall and early winter planting.

4) Maintain leaf removal equipment and test-run for proper operation.

different make or model.

A certain amount of hand labor will always be present in grounds maintenance. Increasing labor costs dictate that each supervisor must continue to search for the right piece of equipment for the job. If unsure of what to buy, consult with other supervisors with similar responsibilities. Most are happy to relate their experiences and will "tell it like it is." Before purchasing, it is usually possible to try out a piece of equipment to see if it really is an asset.

Be sure that everyone responsible understands the importance of preventive maintenance. Adherence to manufacturers' recommendations is essential if a machine is to return its cost in service.

Lawn Mowers

Because lawn mowers represent the biggest part of the equipment investment, it pays to buy only those that meet performance criteria. For example, a mower must have:

1) Exceptional maneuverability of zero to 12-inch turning radius at the cutting head.
2) "Out-front" mowing to eliminate tire streaking.
3) Even distribution of cut grass across the width of the cutting head.
4) Adequate ratio of engine horsepower to cutting width.
5) Minimum use of V-belts in drive and cutting system.
6) Available with enclosed cab, lights, chains, and angle dozer blade for snow removal.

A grounds maintenance team must be a well integrated group of selected individuals, and it must possess a wide range of knowledge and skills. In all phases of the grounds operation, safe working conditions, attitudes, and procedures must be constantly emphasized. Few kinds of work present more hazards. The equipment and chemicals used are dangerous, but safety can be maintained if each person is properly aware of his responsibilities and follows safe practices.

Overcoming Obstacles

Most facilities requiring grounds maintenance have been around for a long time. Unfortunately, older grounds were not designed with current maintenance methods in mind. Conditions particularly troublesome are overgrown landscape plantings, narrow, broken sidewalks, paved inter-

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5) Improve and maintain streets, parking lots, and sidewalks.

6) Hand weed shrub beds and other areas unaffected by control spraying. During dry periods, part of the mowing force can help.

7) Establish new lawn seedings in early August. Irrigate if necessary.

AUTUMN

1) Control early leaf fall by attaching mulchers during final weeks of mowing season.

2) Repair turf with sod as long as soil conditions permit.

3) Fertilize lawns according to program established.

4) Before storing mowing equipment, analyze replacement and repair needs. Order parts and new equipment.

5) Go over all snow moving equipment and establish route and equipment responsibilities for personnel. Identify priorities.

6) Plant spring bulbs before the ground freezes.

WINTER

1) Continually inspect and maintain snow moving equipment. Be sure all engine-powered equipment has enough gasoline in tanks to operate four hours before being sent to job sites.

2) Establish a protected supply of size-selected sand, equal to one-half the average annual volume used. Replenish as used. (Suppliers' stockpiles may freeze and become unavailable.)

3) Keep an adequate supply of snow and ice thawing chemicals on hand.

4) Continue area cleaning and trash pickup when snow is not present.

5) Clean catch basins. Sweep streets and parking lots.

6) Order spring shrub and tree replacements. Arrange for potted spring annuals.

7) Develop or revise lawn care, plant pest, and weed control programs for spring and summer. Order pertinent chemical supplies.

8) Clean and repair all equipment and tools needed for the growing season.

sections with inadequate radii, and improper lines or grades. These areas place restrictions on equipment choices and operating techniques. A systematic elimination or rejuvenation of old and rank plantings may provide enough open space to allow a large riding mower to be used instead of a small, inefficient hand mower. Another example: a privet hedge must be trimmed three or four times a season; thus, reduced labor costs will pay for a Hicks Yew hedge replacement that needs attention only once a year.

Also, it often is beneficial to make certain physical changes in the landscape or modifications to the facilities. Bad drainage may be solved by regrading, tiling, french drains, or installing catch basins. Reseeding of shade-killed grass areas can be eliminated by substitution of the proper mulch over plastic. Deflectors installed at exhaust vents will stop plant material kill. Urns and trash containers at entrances will reduce area clean-up needs. A ribbon of concrete, asphalt, or gravel installed over plastic will eliminate weeds and grass growth where car bumpers overhang.

Analyze the condition and position of shrubs, trees, and other plant material. Eliminate or relocate them to create a balance between esthetics and economical maintenance. Resist the impulse to overplant. Choose plant materials that are vigorous and compatible with all the growth factors in the area. Avoid trees and other plant material with known susceptability to insect and disease damage. Avoid repetitious planting of the same material. Insects and diseases unknown at the moment can create high maintenance and replacement costs if certain predominate species become susceptible.

Be constantly aware of growth habits and space requirements at maturity.

Complete grounds control must include giving trees, shrubs, and lawns a helping hand to maintain health and vigor. An inventory of kind, number, location, and condition of plants provides a basis for several programs designed to combat damage by insects, climate, and people. Experts in ornamental horticulture and forestry at state universities are equipped to diagnose problems and recommend remedies.

Comprehensive soil testing is a first step in establishing a lawn program. In general, trees and shrubs do not need special attention and receive needed additional feeding during normal lawn fertilizing. However, it is advisable to help trees surrounded by expanses of concrete or asphalt paving. This unnatural environment weakens trees, particularly those established before construction. Under stress, such trees slowly decline, become subject to disease and insect damage, and eventually die.

An attitude of always looking for better ways of doing things best characterizes effective, cost-controlled grounds maintenance. If an accurate diary could be kept over a long period of time, the first discovery would be that subtle differences distinguish each major activity from year to year. An attempt to treat each year the same as the last with hard, fast rules will result in decreasing productivity and a declining vigor of the landscape.

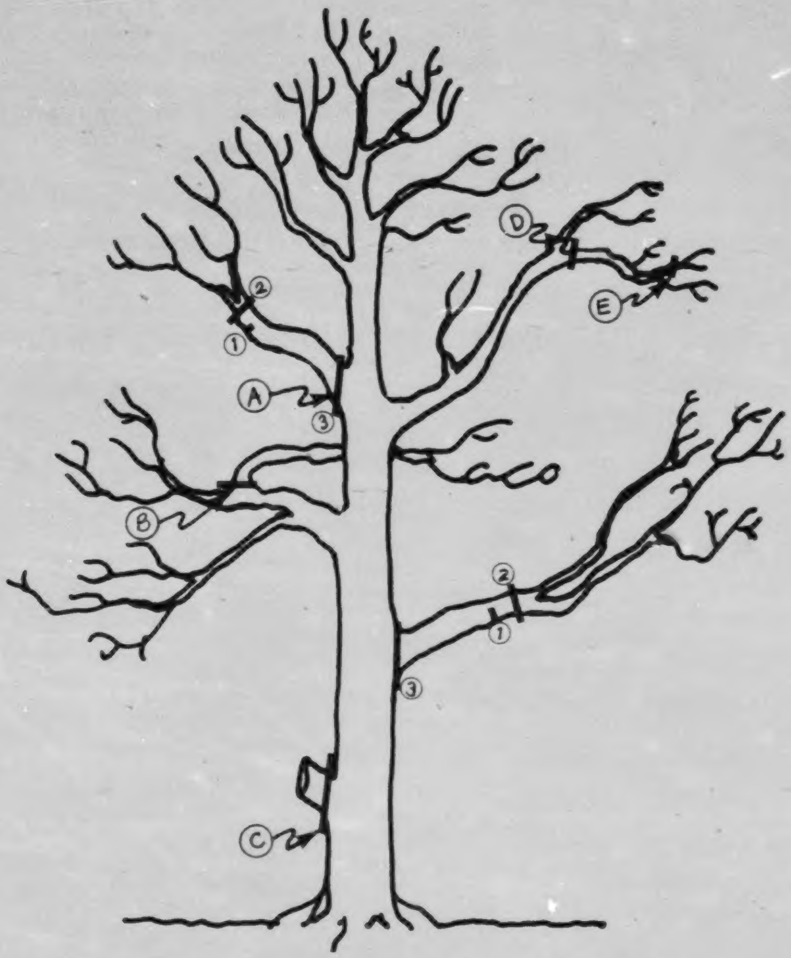
A suggested seasonal schedule is presented on pages 42 and 43. Note that this schedule may need to be coordinated with the building exterior maintenance program (page 39) in many situations, depending upon size of staff and how workload is divided.

Tree and Shrub Care

Pruning insures proper growth and form. Caution should be taken to prune trees and shrubs at the proper time of year.

GOOD PRUNING

1) Use tools that are sharp and clean cutting.
2) Start shaping trees at planting. (Figures 17 and 20)
3) Diseased, dead, or broken branches should be removed at any time.
4) Leave no stubs or ragged cuts.
5) If two branches are rubbing or interfering, causing bark wounds, prune the weaker branch.
6) Always cut back to another branch or bud. If the end of the branch is dead, cut beyond and close to a bud.
7) To be sure the branch is dead (not dormant)



On all heavy cuts, make removal in three steps:

① Make a partial "undercut."

② Remove the limb above the "undercut."

③ Remove the stub at shoulder rings.

Ⓐ Remove weak crotches.

Ⓑ Remove "cross-over" or interfering branches.

Ⓒ Prune back to side branches, laterals, or main trunk. Never leave stubs.

Ⓓ On average high cuts, use a pole saw.

Ⓔ On small high cuts, use pole pruners.

FIGURE 17—Good pruning techniques are essential in keeping diseased, dead, and broken branches removed at all times.

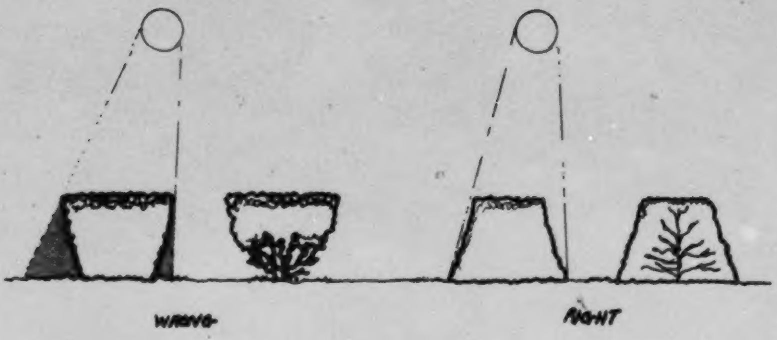


FIGURE 18—Wrong way to trim hedge is shown at left, where overhanging top edges shade the sides. The sides soon lose their leaves and become thin. In the properly trimmed hedge at right, the top is narrower than the base and the sides slope outward. Thus the entire hedge is exposed to sunlight and will grow healthy, compact, and dense.

slice the bark and look for green wood.

8) Prune off one-fourth to one-third of branch growth when planting plants with bare roots.
9) Bark wounds an inch or larger in diameter should be covered with an asphalt base wound dressing.
10) Thin and remove old wood from established shrubs. This produces more flowers, better fruit, and improves vitality of the plant.
11) Trees and shrubs should not obstruct the view from the window of a building.

PRUNING HEDGES

In the spring, heavily prune newly planted hedge down to six inches. Prune again in the summer to 12 inches after new growth has developed. This will encourage side branching and make a wide-based hedge easier to establish. (See Figure 18.)

PRUNING EVERGREENS

Shrubs: Do not remove lower branches. They should grow and branch to the ground. Remove dead branches.

Broad-Leafed Evergreens (Mountain Laurel, Rhododendron, etc.): Do not prune except to remove dead wood. If they reach an undesirable height, cut back to the ground. New growth will form.

Narrow-Leaf Evergreens (Juniper, Arborvitae, Taxus): Prune in the spring, removing whole branches. Prune no more than one-fourth of the total plant growth. Cuts should be deep in order that foliage may conceal the branch stubs. This method leaves the plant in a more natural state.

Narrow-Leaf Evergreens (Spruce, Fir, Pine): These evergreens are not generally pruned. Exception: When the plant is less than five feet tall, to increase foliage density. (Figure 19)

Shear no more than one or two inches of foliage. Use hedge shears on arborvitae and hemlock hedges. Do not expose new wood. New wood cannot be covered, since new growth of evergreens is entirely from the ends of the branches.

Flowering Shrubs (spring flowering shrubs): Prune after the blooming period. The flowers are borne on the wood from the year before. Pruning right after the blooming period assures more flowering wood for the next year.

Flowering Shrubs (summer flowering plants): These plants that produce flowers on wood of the same year may be pruned in the spring before growth begins.

When the plant becomes dormant, fall pruning

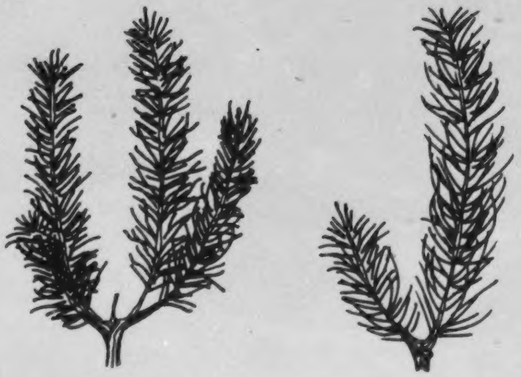


FIGURE 19—Evergreen pruning. The pine on the left shows a lost leader (stub in the crotch). The three one-year-old shoots will compete, probably making a triple-trunked tree. For corrective pruning (right) competing growth has been removed entirely or cut back to half, leaving the strongest, most upright shoot to serve as a leader. Pruning cuts should be sealed. In a few years the trunk will make sufficient secondary growth so the injury will not be noticed.

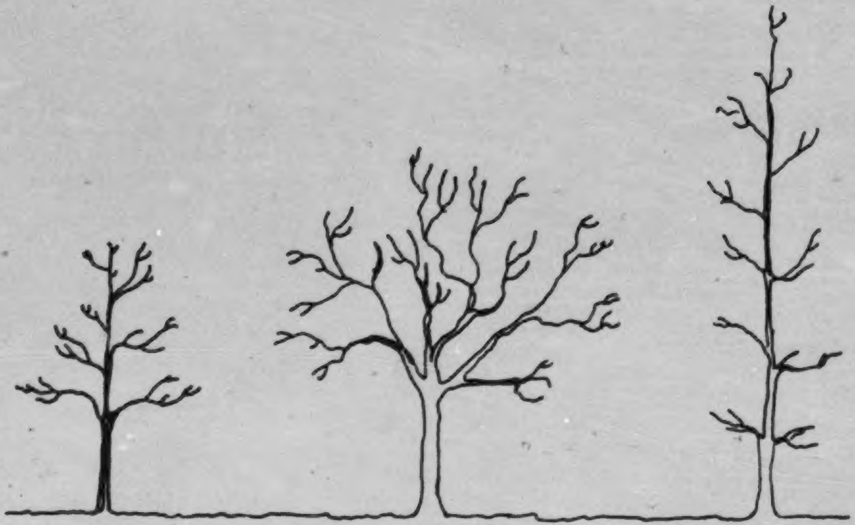


FIGURE 20— Starting with a young shade tree (left) proper trimming determines ultimate shape. For a compact, open spreading tree (center) remove the central leader at the height where the tree is desired to crown out. Side branching also is encouraged by removing terminal buds or pruning twig ends. For an upright growth right) protect and encourage the central leader and remove the side or lateral growths. To develop a strong trunk, leave low side branches on for a year or two but keep them headed back and remove them as the tree develops.

(after flowering) works well.

Shade Trees: Young shade trees need little pruning. In the first year, encourage upward growth by cutting branches that are too low. The remaining side limbs can be shortened from one-fourth to one-third.

During the second and succeeding years, remove fast growing limbs that tend to crowd or compete with the main limbs. See Figure 20 for guidance in shaping a shade tree.

Full grown shade trees require little pruning except to remove dead and diseased branches.

PRUNING METHODS FOR SHRUBS

Rejuvenation: Used on plants that have become too large for the space, or so old they are loose and do not flower well. (Figure 21). To prune, cut the oldest branches off at the ground. Leave the young stems, gradually remove older wood over a period of years. Lilac, privet, forsythia, vibrunum, honeysuckle, and barberry are just some of the multi-stemmed shrubs that benefit by this method.

Thinning: Used on plants that are too dense. (Figure 22) Cut off a twig or branch that is attached to the main stem.

Heading Back: The purpose of this pruning method is to reduce the height or size of the plant,

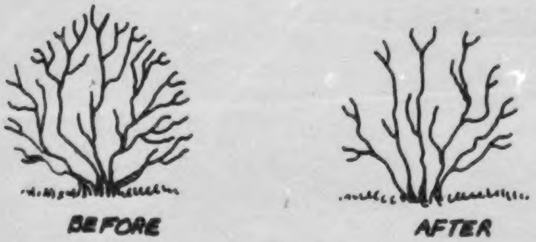


FIGURE 21—To rejuvenate old shrubs, cut the oldest branches off at the ground.

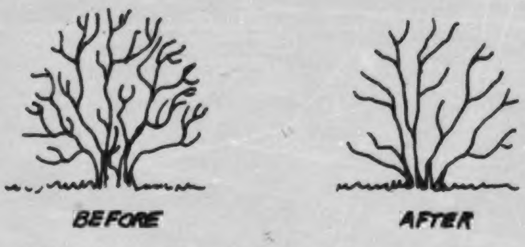


FIGURE 22—Thinning of shrubs that are too dense is done by cutting off twigs and branches where they attach to a main stem.

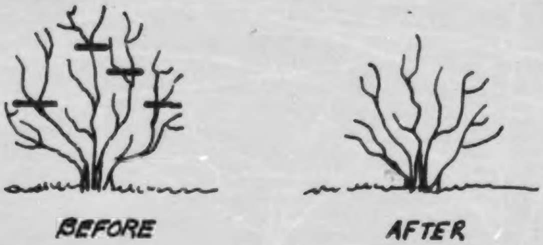


FIGURE 23—Heading back reduces plant size but increases density. Cut the terminal portion of a branch or twig back to a bud or another branch.

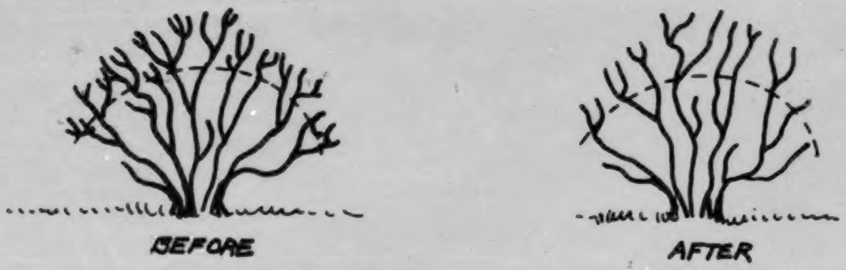


FIGURE 24—Poor pruning technique. Stems and shoots should not be pruned at the same height, because this gives the plant a "crew cut" appearance and stimultes excessive growth on the top of the plant.

and encourages development of small shoots and buds. (Figure 23) Cut a terminal portion of a branch back to a bud of another branch. This creates more density.

Thinning and heading back methods work well together to keep large plants within bounds. Do not prune the stems and shoots the same height – it gives the plant a "crew cut" appearance and causes excess growth on the top. Thinning helps open the center; heading back controls height. (Figure 24)

ROOT PRUNING

Roots of a plant that is to be transplanted should be pruned one year before it is moved. This develops a more compact root system with more roots in the ball of the plant. During the summer when the plant stops growing on top, use a sharp spade, push full depth into the ground around the plant in a circle twelve inches in diameter for every inch of stem diameter. During the rest of the summer the plant will fill out the root ball. The following spring, during the dormant stage, the plant is ready to be moved.

Established trees: Exposed surface roots should be severed and dug out of the turf, a few at a time. These severed ends should be painted with tree wound dressing.

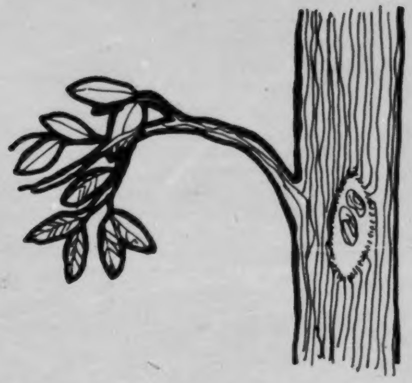
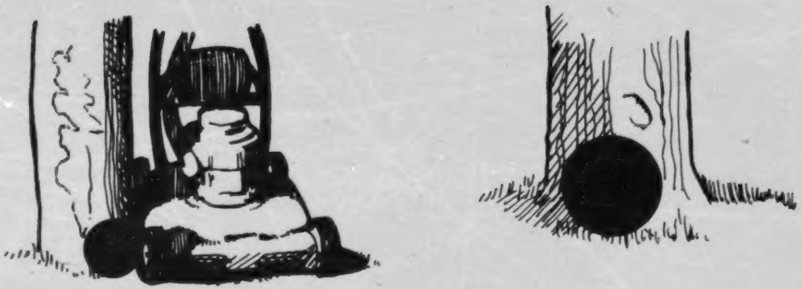


FIGURE 25—Tree wounds. Tree bark abrasions should be treated promptly to prevent decay and enable the wound to close up. Remove loose bark with a knife or chisel and paint the bark above and below the wound. Apply an asphalt-base wound dressing to prevent disease organisms and insects from entering the wound before it heals.

FIGURE 26—Skinning or scraping with a lawn mower can eventually kill a tree. Tree at left has been hit by a mower, creating an open wound. A tree completely girdled by such wounds will die quickly. Even one or two small wounds can let disease or insects enter. The tree at right shows the result cf a fungus disease entering such a wound. Rot has developed in trunk and roots. It is just a matter of time before the tree must be removed.



Building a Lawn

ESTABLISHING TURFGRASS

The general steps in establishing turfgrass for a good-quality lawn are:

1) Make a complete soil analysis.
2) Rough grade.
3) Lime.
4) Apply basic fertilizer.
5) Apply soil amendments, if needed.
6) Till above materials into four to six inch soil depth.
7) Finish grade.
8) Apply starter fertilizer and work into top inch of soil.
9) Apply seed.
10) Rake or drag to cover seed.
11) Roll lightly.
12) Mulch.

Soil Testing

The best guide for proper establishment of turfgrass is a complete soil test. The results of this test offer proper pH and lime requirements and the amount of phosphorus, potassium, and organic matter present in the soil.

Rough Grading

Remove debris, including stones. Before lime or fertilizer application, till the soil and rough grade. Where topsoil is to be replaced or brought in, rough grade to the contour of finished grade in order to facilitate all-over distribution of topsoil. The final depth of topsoil should be at least six inches.

Liming

If the lime requirement test shows a need for lime, broadcast and work in the right amount of ground limestone to a depth of four to six inches. The test will reveal the necessary amount. Where the test is not available, broadcast and work into a four to six inch soil depth at least 100 pounds of ground limestone per 1000 square feet.

Fertilization

Basic fertilization: For soil that has been tested, after spreading, work in the recommended fertilizer to a depth of four to six inches. For soil that has not had a complete soil test, use 50 to 75 pounds of 0-20-20 fertilizer or equivalent per 1000 square feet. Spread and work in to a depth of four to six inches.

Starter fertilizer: Before seeding, spread and rake fertilizer into soil about one inch. Use fertilizer with a 2-1-1 ratio in which one-half to three-fourths of the nitrogen is slowly available (10-5-5, 14-7-7, 10-6-4). Apply at the rate of 25 to 40 pounds per 1000 square feet.

Alternative: 20 to 25 pounds of 5-10-10 fertilizer or 10 to 12 pounds of 10-10-10 per 1000 square feet, when the slow release type is not available.

Soil Amendments

If the soil test shows a lack of organic matter, work in the recommended amount of organic matter four to six inches before applying the starter fertilizer. Recommended sources of organic matter are sedge peat, peatmoss, or a combination of the two.

Well rotted sawdust or manure may be used. However, these do not maintain the desirable soil characteristics as long.

Finish Grade

To finish grade, rake before seeding. Light rolling will point out any irregularities.

Seeding

See page 51 for a discussion of turfgrass varieties that are best for Illinois.

Late summer to early fall is the best time for seeding permanent turfgrass. Recommended time of seeding for Illinois conditions is as follows:

Southern Illinois – September 1 to October 5
Central Illinois – August 20 to October 1
Northern Illinois – August 10 to September 10

Where spring seedings are necessary, for best results seed no later than:

Southern Illinois – April 1
Central Illinois – May 7
Northern Illinois – May 30

Sow recommended seed mixture adapted to use and climatic conditions of the area. For areas of heavy shade (less than one-third of day in direct sun), apply four to five pounds of Creeping Red Fescue or C-26 Hard Fescue per 1000 square feet. North side of building is a good example. For areas of moderate shade (one-half to two-thirds of day in direct sun), sow four pounds of a good mixture of the above Fescues and shade-tolerant Kentucky Bluegrass (Nugget, Aquila, etc.) per 1000 square feet. A good example would be under lawn trees. For areas of little or no shade, apply four pounds of a good Kentucky Bluegrass (Baron, Victa, Aquila/Parage mix, etc.) per 1000 square feet.

If the newly-seeded area will be subjected to high traffic conditions, a mixture containing the good Kentucky Bluegrass and fine-leaved Perennial Ryegrass (Pennfine, Manhattan) should be sown at five pounds per 1000 square feet. This area, once established, should perform well under moderate maintenance programs of fertilization and aerification.

Rake lightly or drag area to cover seed no deeper than one-fourth inch. Roll lightly to firm soil around seed. Small disturbed areas should be seeded as soon as possible, regardless of the optimum seeding time.

Mulching

Use clean straw or marsh hay. Lightly mulch seeded area (may be left on the area to decompose). Do not cover area completely (heavy mulch) as it must be removed after seed germination.

TURFGRASS CARE

Fertilization

Fertilization is the "key" to improving poor-quality lawns and maintaining good-quality lawns.

Grass and green plants need the following: *Nitrogen* for growth and good leaf color; *phosphorus* for deep healthy roots; *potash* to promote disease resistance and is necessary to many plants' physiological processes.

Mowing Turfgrass

For a well groomed appearance and long life, mowing practices are most important.

Height of cut: creeping type plants – produces adequate leaf surface at very low cutting; Kentucky Bluegrass and fine leaf fescues — cut high (two to three inches) to assure satisfactory growth; bunch-type grasses (tall fescue or rye grass) – cut one and one-half to three inches.

Frequency of cut: Frequency is determined by the amount of growth which in turn relates to moisture conditions, season, weather, soil fertility, and the natural growth rate of the grasses.

Mowing practices: Be sure mowing equipment is in good operating condition. Dull, improperly adjusted equipment damages leaf tips and invites disease organisms.

Reel type mowers are recommended for cutting quality turfgrass. Rotary mowers should be used where grass control is more important than appearance.

Dry grass cuts easier; therefore, avoid mowing grass when wet. Cut new grass when it is two inches high. After three cuttings, apply a general weed killer.

Watering Turfgrass

There are three basic concepts to a practical watering program: 1) How should water be applied? 2) How much? 3) How often?

Applying water: Sprinklers should be set for even distribution allowing the soil to absorb the water. Too large a volume of water in a concentrated area causes surface run-off and waste of water.

Amount of water: Enough water should be applied to thoroughly wet the root zone. The type of soil determines its water holding capacity. Loams and clay loams generally have good water holding capacity. Sands have very little.

Frequency: Frequency depends on several things — type of grass, climate (rainfall, temperature, wind movement, and humidity).

Newly seeded areas need to be kept moist

TURFGRASS VARIETIES FOR ILLINOIS

KENTUCKY BLUEGRASS

This species is widely used and thrives in sunny areas. It tolerates prolonged drought, yet comes back quickly after adequate moisture. Kentucky Bluegrass does not tolerate dense shade; therefore, mixtures of the bluegrass with Creeping Red Fescue should be used for variable light conditions.

Barron or Victa are the best varieties of Kentucky Bluegrass in Illinois for high-level maintenance lawns. Their low habit of growth results in a dense turf, and is superior to most varieties of Kentucky Bluegrass in leaf spot tolerance, appearance, vigor, and general turf qualities.

Maintenance: Most Bluegrasses perform well within a two to three inch mowing height. Both Barron or Victa can be cut from 1¼ to 2 inches. Generally, 4 pounds of actual nitrogen per 1000 square feet per year is required for a Kentucky Bluegrass lawn. Dethatching and aerification may be required, especially in areas of high traffic and heavy use.

RYEGRASS

Ryegrass is actually a name given to two closely related grasses. Annual Ryegrass germinates in a few days, gives protection for the slower developing bluegrass and conserves moisture. Perennial Ryegrass such as Pelo, NK-100, Manhattan, may be mixed with permanent grass at no more than 20 percent of the mixture by weight.

Maintenance: Keep Ryegrass 1½ to 2 inches mowing height. Two pounds of actual nitrogen per 1000 square feet per year should be enough fertilizer.

TALL FESCUE

This grass is coarse, grows well in sun or shade, and is used for playground and athletic fields because of its low maintenance properties. It is not desirable in a fine lawn, as the fescue tends to form large clumps throughout the area. Once established, Tall Fescue can only be removed by digging out each area by hand or sod-cutter.

Maintenance: To seed Tall Fescue use the rate of five to six pounds per 1000 square feet. Mow with a sharp mower in the two to three inch cutting height.

CREEPING RED FESCUE

A rapid germinating grass used in seed blends for shady locations. Because it establishes quickly, it gives protection to the slower grading plants, such as bluegrass. Provides fine texture to the turf.

Maintenance: For best turf performance, mow regularly at 1½ to 2 inches. Two pounds of actual nitrogen per 1000 square feet per year are required unless located beneath trees and shrubs, which raises the recommended rate to four pounds per year.

during germination and until the plants are established.

Turfgrass that is wilted enough to retain a footprint needs watering. Watering deeply when plants show signs of wilting promotes healthy turfgrass. Shallow watering encourages weak turf.

GROWING TURF IN THE SHADE

Causes of turfgrass failure under trees is competition for water, light, and nutrients. The following practices may improve turf under trees:

1) Use shade tolerant grasses such as Pennlawn Creeping Red Fescue, Chewings Fescue, Alta or Ky 31 Tall Fescue, Poa Trivialis (rough bluegrass).
2) Fertilize the grass at higher rates than normal.
3) Infrequent deep watering to prevent tree roots from surfacing.
4) Remove trees that do not add beauty to the landscape, nor serve a basic purpose.
5) Prune the tree to the extent the pruning does not destroy its function or beauty.
6) Prune shallow tree roots.
7) Plant new trees wisely. Shade trees should be a minimum of 40 feet apart.
8) Plant trees that present minimum competition to grass (sugar maple, honey locust, bald cyprus).
9) Provide good drainage and aeration.
10) Fall seed the turf. The trees offer less competition at that time of year.
11) The grass clipping height should be higher than that same grass in the open sun.
12) Control weeds, thereby reducing more competition for water, light, and nutrients. *Do not use dicamba.*
13) Remove leaves and other debris promptly.
14) Use other types of ground cover. Suitable plants are baltic ivy, periwinkle, and pachysandra.

Aeration of Turfgrass Areas

Compacted soil as thin as one-fourth to one-half inch greatly reduces nutrient penetration, water infiltration and oxygen and carbon dioxide diffusion. To relieve compaction, mechanical aeration is a means of reducing this serious condition.

Aerating machines punch holes in the thatch layer, creating an artificial system of large pores by which moisture, plant nutrients, and atmospheric gases, entering the pores, create a breathing system through which carbon dioxide can escape from the soil and oxygen can enter the soil. Spring and early fall, when the desirable grasses are growing vigorously, are the best times to aerate. Aeration is a thinning process that reduces plant population by its action. Unless done at the proper time, the turf area may be several months before returning to an attractive lawn.

Lawns that are heavily used should be cut higher than usual to protect roots. Try to have the lawn on the dry side during special heavy use occasions.

Benefits of aeration: Increases surface drainage; relieves soil compaction; provides openings for mulch to work in; air, water, and nutrients can penetrate the soil surface; disease and insect damage is decreased; density is increased.

Equipment with solid spikes is one form of aerator. Coring-type aerators remove a soil core whereas solid-tine spikes do not. Solid-tine equipment must force its way deeper into the soil to achieve the same degree of aeration as a coring type. Coring-type penetrates two to four inches into the soil, whereas solid-tine should penetrate four to six inches. Anything less is wasted effort.

Moss in the Lawn

Low fertility, poor drainage, too much shade, high soil acidity, soil compaction – any or a combination of these cause moss in the lawn. Listed below are corrective measures to follow:

1) Have a regular, balanced fertilizer program.
2) Remove established moss with a rake, 'burning' with ammonium sulfate, or spray with copper sulfate. *Ammonium sulfate* – apply concentrated amounts directly on moist moss. Do not water into soil. *Copper sulfate* – use 5 ounces to 4 gallons of water per 1000 square feet.

When the moss is removed, correct the basic cause and follow with good management practices for a dense, vigorous turf.

Asphalt Surface Care

The key to a good asphalt maintenance program is to know the composition of the material installed and the construction of the area to be maintained.

Spring and fall inspections of asphalt surfaces will indicate the condition of the material and maintenance required.

Information on each asphalt surface and its maintenance needs should be permanently recorded – and kept up-to-date – on a form similar to the example on page 123, in the Management Tools Appendix. Key indications that maintenance is required are as follows:

Weathered surface – Usually gray in appearance, aggregate appears bleached out. Solution: Clean surface and seal coat with top quality asphalt sealer.

Raveled surface – Shows a loss of bitumen, aggregate overlay exposed; caused by frost action; could be insufficient asphalt mix at time of construction. Solution: Clean surface and treat the same as weathered surface. (Figure 27)

Softening – Surface is soft and/or spongy, caused by gasoline or oil drippage and the like. Solution: Clean and scrub with strong detergent; if severe, remove area and patch. (Expedient – brush on heavy coats of shellac.)

Long cracks – Caused by expansion, contraction, or settlement of the asphalt. Solution: Keep free of weeds. In dry weather, clean out crack (one

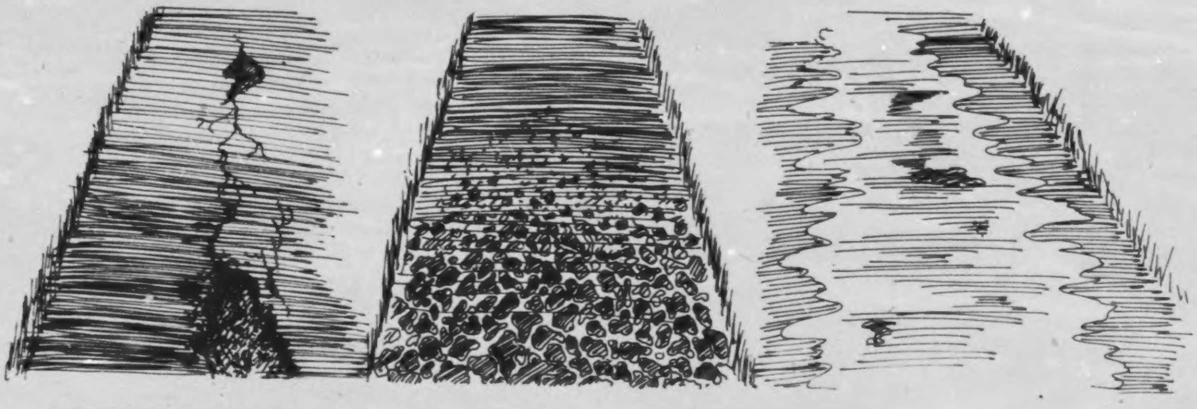


FIGURE 27—Raveling, alligatored cracks, and bleeding asphalt (left to right) are three typical problems in asphalt maintenance.

inch wide or wider) and fill with crack filler.

Alligatored cracks – Series of cracks that look like a spider web. Usually caused by base or sub-base failure. Could be moisture under the surface. Solution: Review traffic pattern to insure surface is not being overloaded. If area is relatively firm and level, seal coat as recommended for weathered surfaces. If area is spongy or has loose sections, remove and patch with asphalt material. If numerous areas are alligatored, complete resurfacing may be required. (Figure 27)

Chuckholes – Breaks in the surface which may extend into the sub-base. Asphalt is loose or missing, forming a hole in the surface. Caused by frost action, general breaking away of wide cracks, or alligatored areas that have broken loose. Solution: Clean out chuckhole down to the base and patch with asphalt patch.

Bleeding or softening – Usually occurs when asphalt is improperly mixed at time of installation, or improper usage of seal coating material recommended for weathered surfaces. Solution: See your asphalt supplier for technical assistance. (Figure 27)

Depressions — Caused by gradual settling of the base or sub-base. There may be long seals or sheared sides because of sudden earth movement. Solution: Remove defective area down to the soil, inspect for water seepage and provide drainage, if necessary, compact soil, reconstruct the area to original condition.

Edge breaking – Usually caused by insufficient lateral support on shoulders, excessive moisture, or excessive dryness which makes the asphalt brittle. Solution: Provide additional lateral support by filling or by use of retaining material. Remove damaged areas and asphalt patch.

Numerous wide cracks, loose sections, and the like – Solution: Clean out cracks one inch wide or wider, fill with crack filler and resurface area with new asphalt cap.

The size, amount, and condition of the asphalt maintained dictates the details for a preventive maintenance program. A maintenance program should begin this way: Inspect, measure, and record the condition and location of all asphalt surfaces maintained. Segregate asphalt surfaces into three groups:

Group 1 – Asphalt in excellent condition.

Group 2 – Asphalt in fair condition; needs cracks filled or minor repair and seal coating.

Group 3 – Asphalt shows complete deterioration; resurfacing is required.

Develop the maintenance program by establishing a list of repair needs, the location, and estimated cost of repair. Divide this list of repair needs by budgeting over a period of three to five years to spread and equalize costs for asphalt maintenance. Asphalt surfaces that are in fair to excellent conditions (Groups 1 and 2) should be the first scheduled for repair. Asphalt that is considered beyond preventive repair (Group 3) can be patched to eliminate hazards until monies are available for complete resurfacing. Over a period of years, as a program is developed for the maintenance of asphalt surfaces, school districts find that preventive measures (seal coating, crack filling, and patch repair) are more economical than complete resurfacing when the surface fails entirely.

Daily Care

Regulate use of asphalt areas to insure that they are not being abused by overload traffic on areas designed for play or the like.

Yearly Care

Inspection: During the early spring, inspect asphalt surfaces for any major changes in deterioration. Adjust asphalt maintenance plan to provide necessary maintenance repairs before complete asphalt failure.

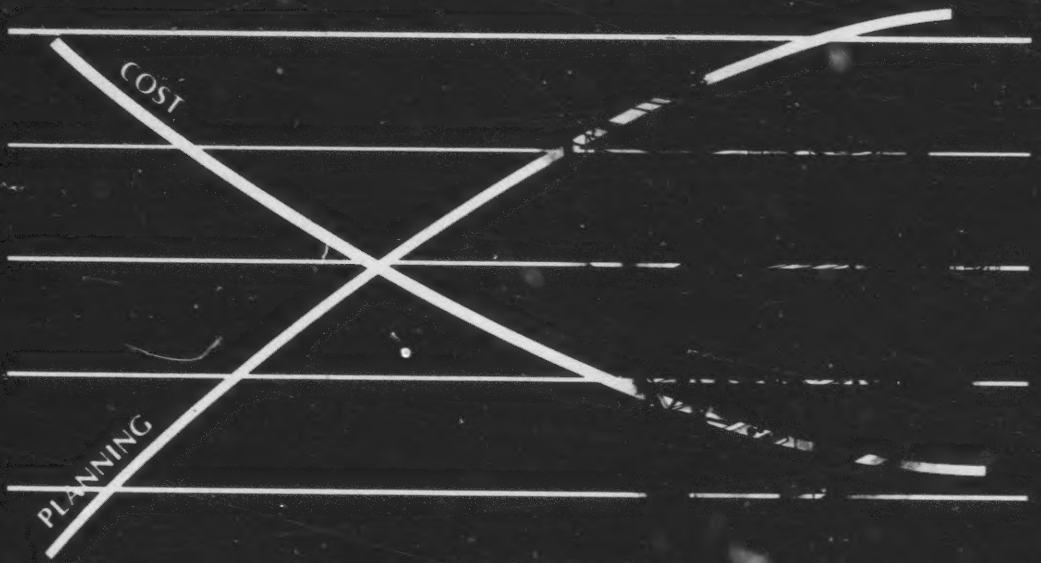
Patch repair: Patch repair of pot holes, broken areas, and cracks of asphalt surfaces areas classed as Group 2. Complete as funds are made available.

Seal coating: Coat with asphalt base emulsion those surfaces classed as Group 1 or 2 so as to resurface each area only once every three or four years. Apply two coats of material each time the area is resurfaced.

Crack filling: Fill asphalt cracks one-fourth inch wide or wider with asphalt crack filler so as to repair these cracks once every two years.

Resurface

Resurface asphalt areas in Group 3 with a two-inch asphalt cap. These areas should have cracks one inch or wider filled with durable crack filler. Major failures must be removed and supported with suitable base before old asphalt surface is recapped. After resurfacing, reclassify area as Group 1 and program for future scheduled maintenance.



Mechanical Equipment

Heating and Air Conditioning Systems

BOILERS

The boiler in a school building, whether it heats water or generates steam, has been constructed to meet various safety standards, including the code of the American Society of Mechanical Engineers. The burner and its controls are equipped to meet the safety requirements of the municipality and insurance company.

The boiler as purchased and installed is capable of safe, reliable, and efficient operation. Such satisfactory operation can be achieved year after year by following the basic maintenance program described in the operators manual provided with each boiler. This manual is a valuable aid in caring for the boiler.

Good boiler maintenance consists of observing, adjusting, cleaning, and lubricating various pieces of mechanical equipment on a regular basis. Boiler maintenance is either protective or corrective. The two may overlap, but usually protective maintenance tasks are routine and are aimed to prevent breakdown and to prolong the useful life of equipment, while corrective maintenance is the repair or replacement of parts as required by occasional breakdowns.

PROTECTIVE MAINTENANCE

Protective maintenance begins with initial start-up. This is the most important step affecting boiler life and the one that is most often abused. Some contractors, for example, will use a boiler for heating a building during construction, without adequate water treatment or other care for firing requirements. Thus, the school gets a badly scaled or otherwise damaged boiler.

Another important step in good maintenance is to keep a log book. Insurance statistics reveal that 75 percent of all overheating accidents occur at installations that do not use a boiler log. Less accidents occur where logs are kept, because equipment maintenance required by a log program usually prevents total failure of safety controls.

Starting Up a New Boiler

Boiler start-up should be performed by the manufacturer's authorized agency. Because of the importance of a proper start-up, the sequence of steps involved is outlined here:

1) Most states require an official inspection. If not, the boiler insurance company will inspect. In either event, the inspection confirms integrity of design and conformance to ASME standards.

2) Inspect all gages, controls, water glass, blowdown piping, relief valves, and others. Short shipments, errors, and vandalism are not unusual.

3) Inspect for foreign objects on both fireside and waterside. Check interiors for rags, scrap material, and tools.

4) Run electrical equipment to check for correct operation and assure lubrication to rotating parts.

5) Fill with water and boil promptly to drive off dissolved gases to avoid corrosion. For steam, fill the boiler to water level. For water, fill the system until the black hand matches up with red hand on the altitude gage. (Be sure the fresh water line is not connected directly to the school water supply unless approved backflow devices are in place and function properly.)

6) Start up the boiler and stand clear of fire doors.

7) Bring up the pressure and temperature slowly. Do not leave unattended while pressure and temperature are rising.

8) Record data in log book. Date and sign start-up record.

9) Operate steam boiler to clean the system. Run until oil and dirt in the piping has washed out with condensate and goes out the drain. Run until condensate stream is clear.

10) Boil out the steam boiler to remove oil and grease. Fill boiler with water to normal level. Mix concentrate of water and one pound of caustic soda and one pound of trisodium phosphate for each fifty gallon capacity of the boiler. Do not splash on skin, clothing, or eyes. Pour concentrate in boiler. Start firing. Boil water for five to ten hours. Drain and pressure flush the boiler interior. Refill the boiler to normal level and promptly reheat to 180° F. The boiler is okay if the gage glass shows clear water. Repeat if glass shows dirty water. Add boiler compound, such as 95 percent sodium chromate plus 5 percent sodium borate (one pound per fifty gallons of boiler water) to keep pH somewhere between 7 to 11.

11) Boil out the water boiler and system by filling boiler and system with water. Mix in a concentrate of the cleaning compounds – one pound of trisodium phosphate for each fifty gallons of water in the system. Circulate through the entire system for five to ten hours. Drain and pressure flush the boiler interior. Refill the entire system and promptly reheat water to 180°F. Add boiler compound, such as 95 percent sodium chromate plus 5 percent sodium borate (one pound per 1400 gallons of water) to keep pH somewhere between 7 to 11.

Starting Up After a Summer Lay Up

1) Check water level, controls, valves.

2) Check burner operability, fuel, air inlet, exhaust breeching, etc.

3) Open water supply to boiler feed and supply and return valves on the boiler.

4) Start up boiler. Stand clear of fire doors.

5) Bring up the pressure and temperature slowly. Do not leave boiler unattended.

6) Examine all gages and safety relief valves.

7) Record data in log book. Date and sign.

8) On a start-up from cold conditions, condensation may occur but will stop when temperatures are stabilized.

9) If a second boiler is to be cut in after the first is fired up:

- Close its supply and return valves. Open condensate drain valves in header.
- Start up as described for the first one.
- When boiler pressure is up and matches line pressure, open supply valve.
- Open the condensate return valve.

MONITORING BOILER OPERATION

Daily Tasks

1) Read the pressure gages and temperature gages several times daily.

2) Look at the water level glass gage. Water should be visible in the glass at all times. If not visible, shut the burner off. Do not turn on feed water. Do not open safety valves. Let the boiler cool to below 212° F, then add water until one inch shows in the gage glass. Do not start the boiler until the trouble is corrected.

- Water in the gage glass should be clear. Any appearance of rust indicates corrosion. Make chemical check for pH. It should range from 7 to 11. Make check for chromate content.
- Water line should be steady. Bouncing indicates priming or foaming and can be caused by too high a water level, excess dirt, excess oil, excess chemicals, or by over firing.

3) Check the water gage and tri-cocks. Close the lower gage glass valve. Open the drain cock and blow the glass clear. Close the drain. Open the gage glass valve. Water level should bounce up immediately. If not, purge out the lower gage glass pipe line.

4) Check the low water cut-off. Open the drain valve on the water column to lower the water and drop the float. The burner should shut down. If not, have a competent serviceman make repairs before refiring the boiler.

5) Blow down boiler to remove sludge and sediment. A clean, properly maintained boiler should not be drained except to remove sludge, to

make repairs, or to lay up for long periods.

6) Turn off the power control switch to observe burner shut-down and the response of the flame failure equipment.

7) Check out the operating point of the operating control and of the high limit control.

8) Keep the boiler room clean. Good housekeeping is essential to efficient operation and safety. Don't let trash interfere with a competent operation.

9) Keep the burner cabinet door closed. Electrical contacts are very sensitive to dust and dirt.

10) Keep a constant check on the fuel supply. Don't depend on automatic delivery. These checks may spot leaks and prevent a hazardous situation.

Weekly Tasks

Each week, inspect the following for proper operation:

1) All linkages on the burner controls and on the automatic draft controllers;
2) Air damper on the burner;
3) Valves in the gas train;
4) Pilot and ignitor, condition of the flame;
5) Low water cut off. Open the boiler drain and blow down until the burner shuts down. Watch the gage glass. The burner should shut off before the water drops out of sight.

Monthly Tasks

1) Check out the operation of safety valves. Make a try lever test. Two people should coordinate for safety. Blow steam for five seconds. Let go of try lever. The valve should snap shut and seal tight. If it simmers, blow again. If valve does not seal after three trys, replace it. CAUTION: Be sure hot water or steam is discharged at a safe point.

2) Check out the limit control on the boiler. Shunt the operating control, allowing operation to continue so that you can check the functioning of the limit control. CAUTION: This step should be performed only by an authorized service representative.

3) Check out the burner flame detection control. Turn off burner control switch and close pilot manual gas cock. Turn on burner control switch, and determine that burner flame safeguard locks out on flame failure before the main gas valve is energized. Immediate corrective action must be taken by a competent serviceman if the flame safeguard does not warp out to indicate flame failure.

4) Blow down the boiler to remove sludge. Open the drain valve at the bottom of the boiler and close it as soon as it is full open. This will usually be enough to remove bottom sludges. On high pressure boilers, there are dual valves. The correct operation is: Open the quick opening valve first, then the slow opening one; close the slow opening valve first, then the quick opening one.

5) Check the floor drains for proper function. If not used often, the water in the trap can evaporate. If necessary, drain water to fill the trap.

6) Lubricate motors in accordance with the manufacturer's instructions. Don't over oil.

Annual Tasks

1) Disassemble the low water cut-off and check for binding, corrosion, or electrical switch defects. CAUTION: This step should be performed by an authorized service representative.

2) Conduct a hydro-test on the boiler and look for leaks at pipe joints and tube joints at the tube sheet. CAUTION: This step should be performed by a licensed boiler repair shop.

3) Inspect the waterside and perform cleaning operation. CAUTION. This step should be performed with the help of a licensed boiler repair shop.

4) Tune up the burner settings. Clean nozzles. The amount of CO_2 present in the flue gas is an important measure of fuel efficiency of any burner. It should average about 10 percent for gas fire and about 12 percent for oil fire. Tune-ups are essential and will yield substantial fuel savings through increased efficiency. CAUTION: This step should be performed by an authorized service representative.

5) Inspect refractory for broken chunks that have fallen out.

6) Inspect the fireside and perform cleaning operation.

7) Check the gas regulator pressure setting. CAUTION: This step should be performed by an authorized service representative.

8) Inspect the boiler room fresh air inlet screens and clean if necessary.

9) Make a safety pop test. CAUTION: This test should be made in accordance with instructions of the government boiler inspector or by a licensed repair shop.

Annual Inspection

Boilers should be included in the annual inspection of heating and ventilating systems. See the Annual Inspection Checklist on pages 141 to 147.

CLEANING BOILERS

Inadequate cleaning is a major cause of boiler failure. A number of steps are essential in keeping boilers clean. A need for cleaning usually is indicated when stack temperatures reach 100° F. higher than when the boiler was new and operating under similar pressure and load conditions.

Fireside cleaning: Deposits from fuel, such as sulphur, vanadium, and sodium, are corrosive and should be prevented or removed. Cleaning as follows will restore efficiency (12 to 24 percent) and prevent corrosion.

- Both flue tubes and smokeboxes should be cleaned.
- Soot is removed with air or steam using soot blower jets.
- Carbon is removed with tube scrapers or brushes.
- Cleaning may be done during operation. Cleaning should be done during boiler lay up.

Waterside cleaning: Impurities in water will form scale on metal surfaces and water treating compounds will form precipitates that settle out as sludge. Cleaning as follows restores efficiency (about 6 to 12 percent) and prevents hot spots and overheating.

- Blow down the boiler at a bottom drain to remove sludge.
- Blow down the surface to remove grease and scum.
- If blowdowns will not provide sufficient cleaning, boil out the boiler once or twice a year.
- If scale needs to be removed, have it done only by a licensed repair shop.
- Feedwater treatment and proper blowdown procedures are important to keep boiler surfaces free of scale to prolong boiler life. Feedwater consultants should be contacted to analyze the water and recommend treatment. Consultants also should recommend the blowdown procedure and frequency of blowdown to reduce concentration of impurities in the boiler.

Note: Water treatment is covered in more detail beginning on page 64.

REMOVING BOILER FROM SERVICE

For periods less than one month:

- Drain boiler water while hot, from bottom drain, until it runs clear.
- Refill to the *top* of the water glass.
- Add water treating compound: sodium sulfite to 100 ppm or sodium hydroxide to 400 ppm.
- Boil out all gases and then shut down burner.
- Seal the boiler by closing all boiler operating valves.
- Clean soot off tubes and fireside surfaces. Swab with oil.
- Place one pound of quicklime per boiler horsepower and seal up fireside.

For periods over one month:

- Drain boiler water completely, while hot, from bottom drain.
- Dry the waterside using hot air or newspaper fire.
- Place one pound of quicklime per boiler horsepower and seal up waterside.
- Clean soot off tubes and fireside surfaces. Swab with oil.
- Place one pound of quicklime per boiler horsepower and seal up waterside.

Be sure to remove the quicklime prior to startup. Use care, as quicklime causes serious skin burns on contact.

CORRECTIVE MAINTENANCE

Corrective maintenance is the repair or replacement of parts as dictated by occasional breakdowns. Major repairs should be done by a boiler serviceman. The following repairs can generally be handled by the school custodial staff.

Leaks

Repair all leaks promptly. All piping connections to the boiler and accessories should be kept leak proof, because even a minor leak, if neglected, may soon become serious. This applies especially to water glass, water level control piping, handhole and manhole gaskets. If serious leaks occur, shut down the boiler immediately, gradually reducing steam pressure. Do not attempt to make repairs while the boiler is under pressure.

Covers and Inspection Plates

Repair leaky handhole or manhole covers by replacing worn gaskets. First, clean the metal surfaces where the cover plate bears against the shell plate. Next apply graphite paste or grease to the gasket to prevent sticking and to make sure it is tight. Always use new gaskets. Make sure the cover plate and gasket are centered before drawing up bolts. Tighten bolts. As steam pressure is raised, tighten these bolts repeatedly to make them leakproof.

Washout Plugs

Use the same method when renewing gasket or washout plugs. Grease the threads so the plug can be easily removed when necessary.

Water Gage Glass

When a water gage glass is broken, remove the pieces and slowly open the valves to blow out any remaining particles of broken glass. Before inserting the new glass, be sure it is the exact length required and that the connections line up. Otherwise it will break as it expands with the heat. Insert the new glass with rubber gaskets, brass rings, and stuffing box nuts. Take care not to set the nuts too tightly in order to allow for expansion from heat. Crack the top valve slightly to let a small current of steam flow through the glass to warm it gradually. Close drain cock and open bottom valves slowly. When water level is stable, open wide both top and bottom valves.

GAS AND OIL BURNERS

An effective preventive maintenance program is absolutely essential to the safe, dependable, and efficient operation of fuel burning equipment. Preventable equipment failure — causing a boiler to overheat — is extremely expensive in terms of replacement equipment and days of school lost. In addition, a good maintenance program will result in more efficient fuel use and reduce energy costs.

Effective maintenance begins with knowledge of the equipment and how it should operate. Thus, preventive maintenance begins with these first steps:

1) **Obtain two copies** of the parts and service manual from the manufacturer. Data and instructions of allied equipment, such as combustion safety equipment, and automatic valves, should be included in this book. If they are not provided, take steps to complete this manual by contacting the various manufacturers directly or asking the boiler manufacturer for them. One copy of the manual should remain in the boiler room and the other in an office file. Be certain that the wiring diagram, sequence of operation, the piping diagram showing valve train, and other necessary information for the particular installations are recorded in this manual.

2) **Before attempting** to maintain the burner, it is important to know exactly how the burner should operate. Obtain this information from the consulting engineer or the burner manufacturer, using the Burner Information form provided on page 124 in the Management Tools Appendix. This form should be put in the office files and the information recorded in the parts and service manual.

3) **On a new installation,** see that the maintenance team receives a demonstration of the burner operation by either the contractor or the burner manufacturer's representative. Be sure to get a clear and accurate explanation of every step of the burner operation and what precautions to take in the event the equipment fails to operate.

4) **Obtain a recommended** list of replacement parts from the burner manufacturer's representa-

tive and then determine what parts will be maintained in stock. Obviously, the distance and time from the source of supply are important factors in deciding what spare parts to stock.

5) **Determine what service organization will be used.** Record day and night telephone numbers, addresses, and other needed information near a light in the boiler room, as well as in the parts and service manual. This information should be readily available so that even a person unfamiliar with the burner operation could, in an emergency, call for service.

MAINTENANCE SCHEDULES

Once the operators are familiar with burner operations through both demonstration and reading of the parts and service manual, a maintenance schedule should be drawn up. The printed schedule should outline what is to be done and should be arranged so that each operation can be recorded and initialed by the operator doing the job. This will provide a permanent record of the daily service performed. The following services and frequencies are suggested:

Daily

1) Observe the burner operation as it goes through its various cycles, visually checking the gas or oil pressure in either the steam or hot water temperature.

2) Visually inspect the fire. In the case of oil, make sure that combustion is good and that smoke is not being produced. Any fire contact with the side walls of the boiler can form carbon deposits.

3) Keep the burner equipment, controls, and premises clean. If using fuel oil or any lubricating oil, visually check for leaks, determine cause, and correct promptly.

Weekly

Determine that each of the following controls are working properly:

- Low water cutoff.
- Operating control.
- High limit control.
- Electronic safety combustion control — simulate both main flame and pilot failures.
- High ambient temperature alarm.
- Alarm bells and lights.
- Emergency switch.
- Operation of both high and low gas pressure switches — high gas pressure switch cannot be simulated; however, it should be disconnected electrically to be certain of its operation.
- Thermal switch on a barometric damper, if used.
- Low oil pressure switch, if used. A clogged strainer, air leaks in the suction line system, or loose strainer cover will cause oil pump pressure to drop.
- Clean the oil suction strainer. If the compound gage shows a higher vacuum than normal, this indicates that the strainer screen is obstructed with dirt, sludge, or wax.
- Lubricating oil level in compressor oil reservoir. Add oil if necessary.
- Make sure the recommended oil for compressor is used, not a substitute.

Monthly (Mainly for fuel oil systems)

1) Check conditions of the nozzle. Remove the nozzle unit or drawer assembly depending upon the type of burner, whether natural or forced draft type. If No. 2 oil is used, the nozzle should not require cleaning, but inspect it for carbon or deposits. The heated oils, heavy Nos. 4, 5, and 6, may cause carbon deposits on the outside tips of the nozzle. Also, residue can collect in the inside mixer. Clean carefully. Do not use tools that will mar the machine surfaces, slots, or holes in both the inside and outside nozzle tips. Be careful to reassemble the nozzle correctly, and do not change the positions of the diffuser or flame retention head.

2) On burners with a diffuser or flame cone as part of the drawer assembly, remove any deposits that might have formed. If the burner housing or register has a hinged swing-out section, inspection can be made with the diffuser in place.

3) If the burner is a combination gas/oil type, be sure the gas orifices are free of any obstruction.

4) Check compressor operations, noting lubricating oil level and refilling it if required. Be sure the automatic sight flow indicators are clean and show rate of lubricating flow. Clean the sediment strainer in the oil supply line to the compressor. Rotary compressors may be furnished with the lubricating oil contained in a base reclaimer, overhead attached type or separately mounted. These use either suction or air pressure to force feed oil. Overhead suction reclaimer uses an automatic shutoff device to prevent oil flooding when the unit is not operating. Be sure the automatic oil feed valve is operating properly.

5) Reciprocating or piston type compressors

requiring lubrication have the oil supply in the crank case. Add oil if the level indicator shows low oil. Some compressors may be direct connected oilless type requiring no lubrication.

6) Compressors of all types are equipped with intake air filters which must be kept clean.

7) If the compressor is driven by "V" belt, wipe the belt clean and tighten if necessary. Follow the instruction manual.

8) Clean the dirt from the scale strainer screen mounted on the electric oil heater discharge and strainers in any other location in the supply line to the burner.

9) Lubricate the bearings on the burner jack shaft and all linkage that operates air louvers and fuel valves.

10) Note the operation of the oil pump, which may be either integral or remote. Noisy operation may indicate either clogged strainer causing high vacuum or air leaks in suction line or shaft seal causing low volume. Also, a low suction temperature when high viscosity oils are burned will cause pump noise.

11) If the oil pump is "V" belt driven, adjust it to the proper belt tension.

12) Inspect the electronic flame safeguard and all motor starters, contactors, and relays. Clean all contacts with recommended cleaning fluid. Never use emery or sandpaper.

Semiannually

1) With instruments, measure and record: stack temperature, CO_2, and electrical signal strength of the electronic flame safeguard system. On gas-fired burner, check CO_2; on fuel-oil burner, check smoke scale.

2) Check belts; tighten or replace as required. Oil or grease motors. Some motors do not require either grease or oil; others require it only once or twice a year. Follow the instructions of the motor manufacturer.

3) On oil systems, drain oil from compressor reservoir, flush out with light flushing oil, and replace with fresh oil.

4) Inspect boiler tubes or flue passages and clean out any ash or soot. If the boiler has spitter blades or tubulators, be sure they are clean before replacing them — they are essential to efficient boiler operation.

Annually

1) Replace electronic tubes.

2) Replace electrodes and insulator in the gas electric ignition system.

3) On oil burners, check the oil filter and replace cartridges.

4) If the oil burning system is equipped with steam or hot water operated fuel oil heaters of the straight or bent tube type, they should be cleaned if required. Usually, tubular oil heaters should not require cleaning the first year unless the oil heating capacity drops while all other conditions remain normal. First, check operation and calibration of the steam oil temperature controls, because a heater may deliver oil at too low a temperature if a regulator is defective or out of adjustment. Steam capacity to the heater may be reduced by a clogged steam strainer ahead of the regulator. The steam trap may not operate properly, causing reduced heater efficiency, if its strainer is dirty or the float is not free to operate the condensate valve. If the trap valve does not open, the entire heater will become waterlogged; or if the trap valve remains open, live steam will be blowing through at all times. Some types of traps operate on the impulse principle without having a float mechanism.

5) Hot water oil heaters may be operated with gravity or forced flow hot water using a circulating pump controlled by an immerson temperature control. Be sure the pump and control are operating properly to maintain the established oil temperature.

6) If an electric heater is used on the burner, it should be drained to remove any sludge. After the first year, it would be well to remove the heater element once a year to clean out any heavy residue coating on the heater or the interior of the shell or manifold.

7) Inspect the entire refractory in the boiler and burner throat and determine repairs which must be made. A setting will last longer if the small repairs are made regularly instead of waiting for a major replacement. Also, major replacements are more expensive.

8) Have the service organization that is working on the burner check over the complete operation of the burner, tightening linkage and doing whatever is necessary to put the burner in first-class operation. This should be done either in late summer or early fall. Require a written report from the service organization as to what was done and the overall general condition of the burner.

Annual Inspection

Burners should be included in the annual inspection of heating and ventilating systems. See the Annual Inspection Checklist on pages 141 to 147.

Summer Shutdown

Assuming the burner is not used during the summer, it should be shut down as follows:

1) Shut all manual valves. These generally include the main line lubricated plug cock and the pilot line cock. It is not advisable to burn the pilot during the summer to keep the boiler dry. Moisture generated by combustion is usually greater than the condensation that occurs without a flame. If heat is necessary, an electric light bulb is preferable to a gas pilot.

2) Put the safety combustion control relay in the safety lock out position.

3) Put all disconnect switches relating to the gas burner in the off position; however, the equipment panel should be left on to maintain sufficient heat to remove the formation of moisture that may form within the panel.

4) The boiler section of this manual contains more explicit steps that should be taken for summer shutdown.

SERVICING

Before attempting to troubleshoot, keep in mind that all servicing and adjustments to the burner should be performed only by qualified burner service personnel. Scheduled inspection and maintenance can be performed by the building maintenance team.

1) Make certain that the combustion chamber and flues are purged of any unburned fuel before restarting the burner following any brief shutoff.

2) Always follow the burner operating sequence instructions in turning the burner on or off.

3) Always open disconnect switches before loosening or tightening the flame safeguard mounting or terminal screws.

4) Make certain that all electrical connections are secure, including the flame safeguard relay mounting connections.

5) Never oil any portion of the flame safeguard relay.

6) Unnecessary shutdowns may be prevented by the annual replacement of the flame safeguard vacuum tube (if used), periodic inspection to remove dust and dirt, and periodic checks of burner adjustments.

Maintenance personnel should be familiar with the burner system and all associated parts. An orderly way of checking for failures should be developed. In troubleshooting, maintenance men should keep in mind to start simple. Go on the assumption that the problem is minor, because in most cases it is. Do not look for complicated problems.

With the aid of a wiring diagram, a sequence of operation table and a voltmeter, first check at the source of power to ensure that the signal levels governing burner sequence are proper. Do not spend too much time in any one particular location of the circuit. Above all, recognize operator limitations. Operators can introduce additional problems to the burner if they are not thoroughly familiar with the sequence of operations and controls associated with it. Knowing his own limitations should tell the operator when to stop.

FAILURES

Upon detecting the cause of burner failure, correct it if possible. If the operator cannot correct the problem, but knows the cause of failure, inform the burner service company of the cause. This effort will save time and money. There are three primary ways to check the unit:

Sight — When performing daily inspection of the burner, note the appearance of the flame — color, shape, and the distance it is firing down the tube at low and high fire. If any changes occur, the maintenance man has a clue to possible trouble. For example, there may not be enough air for complete combustion. This could be the result of insufficient air makeup within the boiler room or the air linkage may be out of adjustment.

Sound — The burner should sound the same each time it lights and goes through its sequence of operations. Any detectable change could inform the operator of potential burner problems. For example, the burner should light with a smooth sounding start. If it huffs or puffs on a start, the cause might be venting blockage in the gas train, a pilot too small, too much air, or other problem.

Smell — If any unusual odors are smelled, this may lead the operator to suspect that some of the flue combustible materials are leaking within the room. The cause of such a problem might be an insufficient amount of air for complete combustion, slippage on air louvers, or a similar problem.

The following should be done prior to calling the service organization:

1) Check to see if power is available to the burner.
2) If there is no power, check fuses, emergency switch, control switch, and summer-winter or heating-standby switches. Reset all safety devices.
3) If there is a fuse-link switch located above the boiler, check to make sure it is functional. The burner may have gone off on high temperature.
4) Check the low water cutoff; some have manual reset.
5) Check the high steam pressuretrol or high water pressuretrol or temperature controls associated with the burner. Many of these have a manual reset and may have been tripped due to burner conditions.
6) High/low gas pressure switches have manual reset switches. They may have been tripped by unusual gas conditions within the area.
7) Check gas cocks and burner fuel supply.
8) Check the flame safeguard for safety shutdown and lockout.
9) Visually inspect the sequencer, internal fuse, tubes, and flame scanner.
10) Check the low fire start switch on the burner.
11) Check the combustion air damper motor and the end switch.
12) Check the thermo switch associated with the barometric damper if the system has one.
13) Check the inducted draft fan and associated fuses, broken belts, or burned out motor.
14) Check burner motor overloads on the starter and panel or on the motor itself.

On completion of the basic checks listed above, note which safety had the unit off and correct the failure. If none of the above can be picked as the cause of the problem, call the service organization that normally maintains the burner equipment and advise them of the steps taken.

WATER TREATMENT

Water for heating, cooling, and other uses generally comes from underground or surface water sources and usually contains impurities.

These impurities are usually classified as dissolved solids, dissolved gases, or suspended matter. Water is a universal solvent. Almost all substances will partially dissolve in it. To some degree water will dissolve rock, soil, and many metals. It will absorb gases, including air and gases formed by organic decomposition.

In general, underground waters are consistent relative to composition, temperature, and hardness. They usually contain less suspended matter and turbidity than surface waters.

The vast amount of water available and its tremendous capacity for absorbing, releasing, and storing heat make it ideal for use in heating and cooling. Before using any water, however, the impurities must be removed or controlled by water treatment.

THE CHEMISTRY OF WATER

A few basic facts regarding the chemistry of water might be helpful.

The *pH* (chemists' abbreviation for the degree of acidity or alkalinity) of water is a delicate balance between hydrogen ions ($H+$) and hydroxide ions ($OH-$). When the hydrogen ion ($H+$) predominates, the water is acidic. If the hydroxide ion ($OH-$) predominates, the water is alkaline. The degree of acidity or alkalinity is determined by the relative amounts of $H+$ and

OH− ions. This degree of alkalinity or acidity is based on a scale of 0 to 14. Above pH 7, water is considered alkaline; below 7 it is considered acidic. At pH 7, water is considered neutral, but it is aggressive.

The alkalinity of water is influenced by hydroxide ions and by carbonate and bicarbonate ions. When water is tested for alkalinity, test for the combined amounts of hydroxide, carbonate, and bicarbonate ions. This amount is normally reported as ppm (parts per million) or mg/l (milligrams per liter) calcium carbonate. When testing for pH, measure the relative amount of hydrogen and hydroxide ions present.

Some waters contain calcium and magnesium salts in great abundance. The amounts of these particular impurities constitute the hardness of the water. They make water difficult to wash with because they react with soap to form a curd. Like alkalinity, the hardness is reported in grains, ppm or mg/l calcium carbonate.

There are many other factors which influence the chemistry of water, but these are the basic ones.

HOT WATER BOILERS

Hot water boilers are perhaps the easiest to treat. A treatment which has been found to work well is to add baking soda to achieve and maintain a pH of 8.0 to 8.5. The pH of the boiler water should be tested monthly to determine if it is in the proper range. Lower pH may produce corrosion on the water side of the boiler. Additional baking soda should be added if necessary.

Where high pH is not practical, chromates and nitrites have been used as corrosion inhibitors. The discharge of these chemicals to a sewer could disrupt a sewage treatment plant and cause it to pollute the natural waters. Therefore, their use should be minimized.

pH can be tested by using pH indicator paper available from any laboratory supply company. The school chemistry laboratory may have a pH meter. If so, use it.

The boiler should be flushed and refilled as required to remove sediment. Be sure to bring the pH back to 8.0 to 8.5 after refilling.

STEAM BOILERS

The treatment of steam boilers amounts to the control of four factors: (1) boiler deposits, (2) corrosion, (3) foaming, and (4) caustic embrittlement.

The main source of boiler deposits is the dissolved minerals contained in hard water. These deposits are generally classified as scale or sludge (mud). The term scale is used to describe the deposits which adhere to boiler water surfaces. The deposits which do not adhere (drop off) are called sludge. The purpose of boiler treatment is to chemically change dissolved minerals which will form scale in the boiler to an inert form of sludge which can be removed from the boiler by blowing down or flushing.

The treatment of mineral matter (hardness) in the feed water can be handled by external softening or internal softening. Water is softened externally prior to entering the boiler by installing a softening system, such as a sodium zeolite or lime softening system.

Hardness can be removed internally by adding to the boiler water one of the sodium phosphates listed below:

Mono-sodium phosphate, anhydrous
Mono-sodium phosphate
Di-sodium phosphate, anhydrous
Di-sodium phosphate
Tri-sodium phosphate
Sodium meta-phosphate
Tetra sodium hypo-phosphate

The phosphate level should be maintained at 30 to 60 ppm. This results in zero hardness of your boiler water.

In the past few years another treatment for hardness has proved successful. This treatment uses chelates such as EDTA to modify complex calcium ions and magnesium ions so they are harmless to the system.

Corrosion in boilers is usually caused by dissolved oxygen reacting with ion in the boiler and by carbonic acid, which is produced when carbon dioxide dissolves in water.

Dissolved oxygen can be removed externally with mechanical deaerators. Some type of chemical internal removal should also be used, however. Internal dissolved oxygen is removed by the addition of sodium sulfite (oxygen scavenger). A level of 30-60 ppm sulfite should be maintained in the boiler at all times. Hydrazine is also used, but usually only in high pressure boilers.

Carbon dioxide is removed by creating an environment in which it cannot exist. This is handled by adding caustic soda (NaOH) to the boiler water to produce a pH of 10.5 to 11.2. Once a pH level of 10.5 is established, it will normally remain in the proper range. If the pH exceeds 11.2, the danger of caustic embrittlement of the boiler metal exists. If this high pH occurs, quickly drain and flush the boiler, refill, treat with chemicals and resume operation.

Foaming and/or priming in a boiler are usually caused by oil or excessive solids (dissolved or supended) in the boiler water. If the problem is caused by oil, the source of the oil should be located and eliminated. The dissolved solid levels in the boiler are controlled by blowdown. The only measurement of blowdown is the chloride level in the boiler water. A chloride level of 80 to 100 ppm normally indicates adequate blowdown. Higher chloride levels indicate insufficient blowdown and that solids may be high enough to cause foaming.

There is a simple test to determine if a steam boiler is foaming or priming. Build up a reasonable load of steam in the boiler and then very slowly open the safety valve on the boiler. If water is discharged through the safety valve, the boiler is priming or foaming, and the oil or solids must be removed. CAUTION! The water which is discharged by the safety valve is scalding hot; stand clear of the valve and the water stream.

Oil can be removed from a boiler by using Sal Soda as follows:

1) Completely drain the boiler from all low points to remove all possible sediment.

2) Add water and Sal Soda to the boiler until it is filled to the proper operating level. Use Sal Soda at the rate of 5 to 10 pounds per 100 gallons of boiler water.

3) Gradually heat boiler water. All air and steam should be carefully vented to the atmosphere.

4) Continue to heat the boiler water, and when the water becomes hot, slowly add additional fresh water to overfill the boiler through the highest available opening to remove any oil deposits which float on the water surface.

5) Maintain the water at boiling for at least an hour and then slowly drain the water completely.

6) Refill the boiler with water and again overfill it. Again heat the water to boiling and completely drain again.

7) It may be necessary to repeat steps (2) to (6) several times to fully clean the boiler and step (6) two or three times to completely remove all traces of Sal Soda.

8) Refill the boiler to the normal water level and add required treatment chemicals.

In high pressure boilers, the breakdown of bicarbonates in the boiler water can form free carbon dioxide ($C0_2$), which will leave with the steam to the system. In turn, this free $C0_2$ forms corrosive carbonic acid when it dissolves in the water in the return lines, producing vigorous corrosion. This corrosion of the condensate lines can be controlled by using filming amines, such as octadecylamine or octadecylamine acetate, introduced into the boiler water. Neutralizing amines such as marpholine or cyclohexylamine can also be used.

Ideally, boiler water should be tested at least monthly for the following:

Test	Desired Concentration
pH	10.5 to 11.2
Alkalinity (MO)	200 to 300 ppm
Hardness	Less than 1 ppm
Sulfite	30 to 60 ppm
Phosphate	30 to 60 ppm

If these levels are maintained, boiler operation can be efficient and at lowest cost.

Chemical additions can be made directly to the condensate return tank in powder or liquid form at least weekly. Ideally they should be added continuously by a proportional feed pump connected to the condensate pump discharge line between the condensate pump and the boiler. It should be activated when the condensate pump is operating.

Improperly treated boilers may require manual or chemical removal of scale deposits. Chemical cleaning is difficult and dangerous. It should only be attempted by experienced personnel. Manual cleaning is expensive.

COOLING TOWERS

The treatment of cooling tower water involves the control of (1) microbiological deposits, (2) scale deposits, (3) corrosion, (4) mud and other deposits, (5) foam. Cooling tower water treatment recently has become a problem because of the potential pollution hazard of treatment chemicals.

Seek a treatment which is effective, yet nonpolluting. The use of polluting treatments such as chromate/zinc or chromate/zinc/phosphate will mean the use of expensive pollution control equipment to avoid violations of environmental protection standards.

The best solution is the service of a reputable chemical treatment company. They will evaluate the system and provide an effective non-polluting type of chemical treatment. Many treatments of this type are available but they must be suited to a particular system.

Domestic Hot Water Treatment

The most common problem encountered in domestic hot water systems is the corrosion of pipes by extremely soft water. The softening system should maintain a safe hardness level of 4 to 5 grains per gallon. It should be tested regularly for hardness.

Another common problem is that of scaling of pipes. Control can usually be accomplished by the use of sodium phosphates, sodium silicate, or a combination of the two. Additions should be made with a proportional feed pump. The chemicals used must be approved for human consumption and must be mixed and dispensed under hygienic conditions.

Chillers

Chiller protection by chemical treatment is necessary for efficient operation. These systems are delicate and must be treated properly at all times.

The best treatment is the addition of 2 to 3 ppm of sodium chromate to the chiller water. This level must be checked at least monthly to determine if more chromate must be added to maintain the proper 2 to 3 ppm level.

PUMPS

Pumps installed in schools are confined mostly to a small range of types, thus simplifying maintenance.

Pumps circulate or move water, either in a "closed" system where the water is used over and over again (as in heating or cooling), or in an "open" system where water is consumed or replaced (as in a sump pump or domestic hot water pump). All of these pumps fall into the general classifications which are described in the table on page 68.

Pumps should be inspected weekly and maintenance performed as follows:

1) Motors and pumps must be oiled or greased in accord with the manufacturer's directions. Do not over oil motors and be sure to use the proper lubricant. Pumps with oil cups must be visually inspected to assure proper oil level. Grease lubricated pumps must be inspected every 90 days and lubricated if necessary. It is far better to lubricate with small quantities at regular intervals than to over lubricate.

2) Couplers should be checked at regular intervals, particularly the solid disc types. Worn disc couplers or malfunctioning spring couplers can be a primary cause of bearing failure.

3) Rubber mounted motors should have mounts checked annually for deterioration and all bases checked for loose mountings.

4) Mechanical seals require no maintenance. If seals leak, they should be replaced or they will continue to leak at an increasing rate.

5) "Stuffing boxes" should be checked regularly and should be repacked by an experienced pump man when leakage becomes excessive.

6) After extended shutdown, pump and motor shafts should be turned manually to see that they turn freely and that any deposited sediment is churned before the motor is started.

7) When reinstalling a motor, the shafts must be carefully checked for alignment.

8) Any pumps that are drained and left idle require careful lubrication and the interiors and impellers must be rustproofed.

9) Strainers on the pump suction must be checked at regular intervals and cleaned. The in-

tervals will depend on the amount of water make-up, type and age of piping, etc.

COMMON TROUBLES

Following is a listing of the most common troubles and their probably causes.

Vibration noise can be caused by any of the following:

- Misalignment of motor and pump shafts; they should be within .005 inches both vertically and horizontally.
- Loose pump and motor base mountings.
- Pump base is inadequately "grouted." This means to fill under the base with cement made with a mixture of three parts sand to one part cement.
- Pipe strain on either suction or discharge connections.
- Check pump coupler.
- Broken or worn springs or arms on flexible coupler.
- Worn discs in solid-type coupler.
- Worn motor bearings.
- Worn pump bearings.
- A common misconception is that flexible pipe connectors eliminate vibration. They are primarily for pipe misalignment.

Cavitation noise (sounds like pumping gravel) can be caused by:

- Air in the system. Each system should have some device (air separator, dip tube, etc.) for separating air at the boiler or converter. Do not depend upon automatic air vents for air removal.
- An inadequate supply of water to the impeller. Check for adequate water level in the system.
- Inadequate system pressure. Check gage on

Types of Pumps

Here are four classifications of pumps most likely to be found in a school building:

1) **In-line circulators,** which are mounted directly in the pipe line.

2) **Base-mounted pumps,** which have pump and motor mounted on a common base and connected through a coupling. These pumps may be vertical or horizontal split case, may be single or double suction, and may have suction and discharge openings located in the end, side, or top.

3) **Close-coupled** or built-together pumps, which have the impeller located on the end of an extended motor shaft.

4) **Peripheral turbine pumps,** which can be arranged physically as base-mounted pumps or close-coupled pumps, but have different hydraulic characteristics. If this type of pump is found in a school, it will usually be in boiler feed service. Unlike straight centrifugal pumps, turbines can require impeller adjustments which should be performed by an experienced mechanic according to the manufacturer's recommendations.

All pumps in these categories have some common characteristics and terminology. These terms are listed below:

Electric motor driven, in which the motive power is an electric motor.

Turbine or steam engine driven, in which the motive power is steam or water under pressure.

Stuffing box, in which a variety of mechanical seals or packing may be installed to seal the pumped fluid from the atmosphere.

Mechanical seals do not leak when operating properly, while *packing* requires a certain amount of leakage for lubrication. For this reason, a packed stuffing box is not generally used in a closed water system unless the fluid temperature exceeds the limits of mechanical seals.

Oil lubricated or grease lubricated pumps. The difference between these can be observed generally by the type of fitting provided for lubrication or from the manufacturer's directions.

Removable bearing brackets or internal bearing supports.

Flexible couplers, which allow limited movement between pump shaft and motor shaft, or solid couplers in which the pump shaft and motor shaft are rigidly connected.

All iron, bronze fitted, or all bronze pumps, selection of which generally depends upon pump usage.

pump suction, both with pump running and with pump off. The pressure must be adequate to supply water to the highest point under all conditions. (Gage reading "Vacuum" indicates condition that can damage pump.)

- Inadequate length of horizontal piping on suction side of pump.
- Misplacement of expansion tank; it should be on suction side of pump.
- Inadequate size of suction piping; it must be full size of pump inlet.
- Motor amperage not within motor rating. If above normal, close the pump discharge valve until amperage drops to normal. (Does not apply to peripheral turbines.) If normal amperage cannot be achieved, check with consulting engineer.
- Fouled strainer; always check to insure that it is clear.

Squealing noise may be caused by a lack of lubrication on either pump or motor. It may mean bearing or seal trouble. If squealing comes from the stuffing box, there may be too tight an adjustment on the "gland."

Mechanical Failures — Motors

1) If motor does not reach running speed, check for a defect in the running winding or in the starting switch.
2) If a motor will not start:
    - Check overload heaters and contacts if a starter is used.
    - If fused, check fuses.
    - Disconnect the coupler from the pump shaft. Motor should turn easily by hand. If too tight, then the bearings are bad. If there is too much end-play, then the bearings are worn.
    - Turn on motor and see if it operates with no load.

Mechanical Failure — Pumps

"Frozen" shaft on a pump may be caused by lack of bearing lubrication, by a foreign object caught in the impeller, or by corrosion around the seal or impeller.

For any of these difficulties, pumps of the vertical or horizontal "split case" design may have removable bearing brackets and may be serviced without disconnecting the piping or misaligning the motor. Other styles must be serviced by removing the suction piping before working on seal or impeller.

Safety

Pumps should be treated like any other piece of rotating machinery. All exposed rotating parts should have a guard. When performing maintenance other than lubrication, the local controls as well as the main power disconnect should be turned off and tagged.

Energy

In the original design, efficiency was a consideration in pump selection and system design. However, there may be cases where a pump must be "throttled" to achieve proper system balance. If this occurs, it might be advantageous to trim the impeller to meet this condition without throttling. This can result in a lower amperage draw. The design engineer can advise whether this possibility exists.

Annual Inspection

Pumps should be included in the annual inspection of heating and ventilating systems. See the Annual Inspection Checklist on pages 141 to 147.

STEAM TRAPS

For steam traps in normal service, a typical preventive maintenance schedule is shown in the table below. However, if the traps are subjected to severe service (water hammer present, excessive condensate loads, large amounts of dirt or scale), more frequent inspections and replacement of parts may be required.

Steam traps can fail in two ways — fail to open and fail to close. When a trap fails to open, condensate accumulates in the drip leg and eventually floods the heat exchange equipment. Conversely, when a trap fails to close, it wastes an impressive amount of live steam. The cause of a trap to fail — open or close — varies for different types. However, there are certain things that happen when any trap fails.

Safety

When working with steam traps, remember that they are pressure vessels and contain hot fluids under pressure. *Never* attempt to open a trap body without first turning off the valves in the inlet and discharge lines and allowing the unit to cool.

When testing traps where condensate return lines are overhead, guard against the backflow from other traps or from the return lines. Aside from being a safety hazard, this backflow can produce false indications during trap testing.

When operating the steam trap with a test cock or union connection open, keep away from the hot condensate. Also, do not attempt to direct the trap discharge into a shallow pan, as velocities may be sufficient to scatter the hot liquid and cause severe burns.

CHECKING TRAP OPERATION

There are several methods of checking steam trap operation. One of the easiest methods is to measure the temperature of the piping on each side of the trap. The inlet piping should be hot, and the discharge piping much cooler. Use any good temperature measuring device, such as a pyrometer, to make the readings. If such a device is not available, put on a good pair of heavy work gloves and take hold of both pipes. A temperature difference between the trap inlet and discharge lines can be felt. If both pipes are cold, the condensate is not being removed from the heat exchange equipment. The trap may not be opening, or the line may be blocked. If both inlet and discharge lines are equally hot, indications are that the steam trap is not closing properly. Check other traps on the

Typical Preventive Maintenance Schedule

	Type of Steam Trap			
Procedure	**Inverted Bucket**	**Float and Thermostatic**	**Thermostatic**	**Disc or Impulse**
Check trap operation	2 months	2 months	2 months	2 months
Clean strainer ahead of trap	4 months	4 months	4 months	4 months
Open trap and clean; replace worn parts	12 months*	12 months*	12 months*	12 months*

*Experience will dictate frequency of trap cleaning and parts replacement.

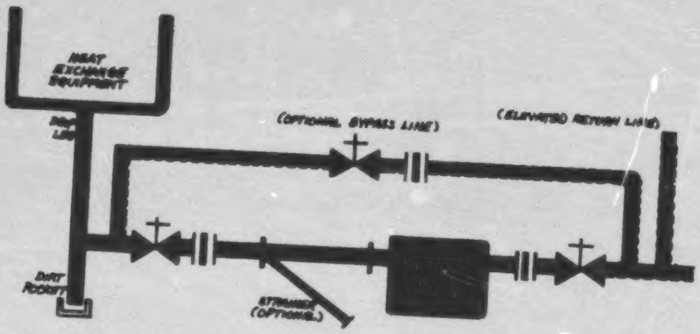


FIGURE 28—A typical steam trap installation.

same discharge line. Often the failure of one trap produces high temperatures downstream of other traps that use the same return main.

Another method for checking steam trap operation is to observe the steam trap discharge. In some installations, a test cock is provided in the trap discharge line. In other installations, it is necessary to open a union connection downstream of the trap to observe the discharge.

Warning: The discharge from steam traps is hot condensate (scalding water) under pressure. When released to atmosphere, the condensate produces considerable "flash steam." Don't get burned. Close valves and allow trap and piping to cool before opening any union. *Be sure* that a valve downstream of the trap is closed to avoid backflow from the return main.

When the steam trap is operating with an open discharge line, notice the type of discharge and the volume of condensate compared to that of steam. Inverted bucket, thermostatic, and disc (impulse) traps have intermittent discharges, accompanied by clouds of flash steam. (See Figure 29.) If a disc trap discharges more often than six times a minute, it is a sign of wear and should be repaired. Float and thermostatic traps discharge condensate continuously as it enters the trap body. Because of the continuous drainage, it is more difficult to distinguish between live steam and flash steam.

When a steam trap appears to be faulty, check the other elements in the pipe lines to be sure that the fault is in the trap. Valves in the trap inlet and discharge lines should be fully open. If there is a bypass around the trap, its valve must be closed tightly. If there is a strainer ahead of the trap, be sure that the screen is not clogged by dirt and scale.

Also check the condensate line downstream of the trap to be sure that it is not fully or partially blocked. If the condensate is discharged to an overhead return line, be sure that the pressure at the trap outlet is sufficient to do the lifting. Pressure must be about 1 psi for every 2 feet of lift.

STEAM TRAP REPAIR

When the trouble has been traced to a particular steam trap, close the inlet and discharge valves and allow the trap to cool. To minimize downtime, remove the faulty trap or trap mechanism and immediately replace it. The faulty trap or mechanism can then be repaired and stored until needed.

Inverted Bucket Traps

To repair an inverted bucket trap (see Figure 30), open the trap and discard the old gasket. Scrape gasket surfaces clean. Remove excessive scale and dirt from the inside of the trap body. Place the cap in a vise and remove the bucket from the lever. Clean the bucket, making sure that the vent hole at the top of the bucket is open. Inspect the valve lever and valve guides for wear. Inspect the valve and seat. There should be a narrow, bright ring around the valve and a sharp edge on the valve seat. If any of these parts are worn, it is good preventive maintenance to replace all parts. When replacing the valve and valve seat, be sure that both new parts are of the correct orifice size

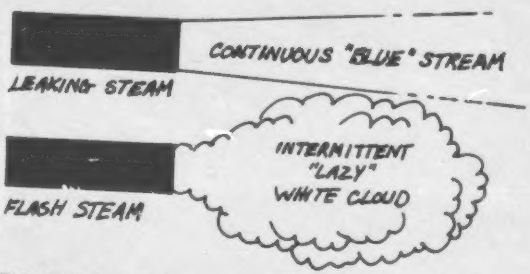


FIGURE 29—Don't confuse flash steam with leaking steam. To tell the difference, open the outlet line. If steam blows out in a continuous "blue" stream, it is leaking steam. If steam floats out intermittently (each time the trap discharges) in a white cloud, it is flash steam.

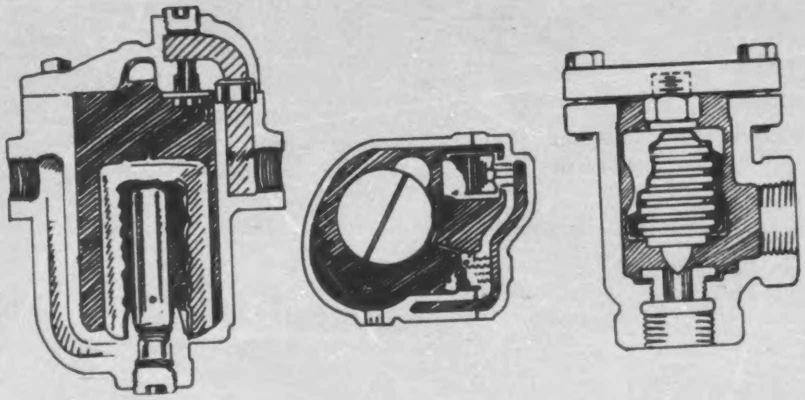


FIGURE 30—Inverted bucket trap (left); float and thermostatic trap (center); thermostatic trap (right).

for operating steam pressure.

Some inverted bucket traps have thermal elements. One type has a bi-metallic strip that closes a secondary vent in the bucket. Inspect the thermal element for wear, misalignment, or other damage. When placed in a pail of boiling water, the vent should close. If the thermal element in the bucket is faulty, replace the bucket. Another has a diaphragm or bellow in the cap. If it has failed, replace the element. (Do not check this type in boiling water.)

After installing the necessary parts in the trap mechanism, align the assembly so that the lever moves freely and the valve seats tightly on the orifice. When the mechanism is aligned so that it operates freely, attach the bucket to the end of the lever. Using a new gasket, reassemble the trap and tighten bolts securely, opposite ones first.

On rare occasions, an inverted bucket steam trap won't close because it has "lost its prime." It can be reprimed by closing the valve in the trap inlet until the condensate accumulates in the drip leg; then by *slowly* opening the valve and letting the water enter the trap. If the trap does not then function properly, something else is probably the cause.

Float and Thermostatic Traps

Generally, float and thermostatic traps (Figure 30) can be repaired without breaking the pipe connections. Remove the cap bolting and separate the cap, mechanism attached, from the trap body. Discard the old gasket and clean gasket surfaces. Clean dirt and scale from the bottom of the trap body.

Inspect all of the working parts for indications of wear or damage. The valve and seat may be worn or wire drawn (steam cut). Lever and pivot pin may be worn, preventing proper alignment of the valve and seat. The float may be collapsed or may have a pinhole leak. The thermostatic element may become misaligned, worn, or damaged. Check the castings for places worn thin by erosion. Replace any faulty parts with new ones. When the valve and seat are replaced, be sure to install the proper orifice size for the operating pressures. Be certain the lever moves freely and the valve seats tightly on the orifice.

Reassemble the trap, using a new gasket between the cap and body. Tighten bolts securely and restore the trap to service.

Thermostatic Traps

To inspect a thermostatic trap (Figure 30), open the trap body and inspect the thermostatic element. Bellows and diaphragm type units may rupture, collapse, or develop leaks. Bi-metallic units may break or corrode. As in all steam traps, the valve and seat may wear so that they do not close properly. When the trap is cold, the valve should be open.

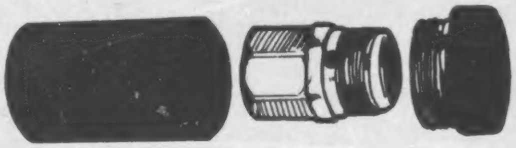


FIGURE 31—Disc trap.

Replace all worn or damaged parts, and reassemble the trap, using a new gasket.

Disc and Impulse Traps

Some disc and impulse traps (Figure 31) must be removed from the line for repair. However, there are some types that require only the replacement of a pre-assembled, factory- adjusted cartridge.

Open the trap and remove the faulty trap element. Clean away the dirt and scale, making sure that the metal-to-metal surfaces are clean. Do not use any gasket or pipe joint compound on metal-to-metal sealing surfaces. Install a new element and reassemble the trap.

Non-Repairable Traps

Some of the newer traps are made of stainless steel and are permanently sealed. If such a trap malfunctions, the problem may be dirt or scale lodged in the trap mechanism. Remove the trap from the line and back-flush the trap with water or compressed air. If there is a check valve in the trap inlet, be sure that it is blocked open during back-flushing. If the malfunction persists, replace the trap with a new one.

Energy Conservation

Because steam traps are relatively small and are often located in out-of-the-way places, their importance is often underestimated. Steam traps are among the factors that determine the efficiency of heat exchange equipment. When steam traps fail to open, unit heaters and radiators become cold and will not heat. Also, steam mains may be improperly drained resulting in reduced steam flow through the main, wet steam, and water hammer. With condensate and air in a steam system, more steam is required to do the work. Excessive loads in some branches can upset the balance of a steam system.

When a steam trap fails to close, that one steam trap can waste more than 200,000 pounds of steam per month (figure based on a 3/8 inch orifice at low pressure). In terms of fuel, that amounts to some 1,900 gallons of fuel or its equivalent.

Annual Inspection

Steam traps should be included in the annual inspection of the heating and ventilating system. See the Annual Inspection Checklist on pages 141 to 147.

Additional Information.

If additional information on the trap sizing is needed — orifice sizes for different pressure, maintenance instructions, parts identification, or application assistance — contact the manufacturer of the traps being used. The manufacturer is identified on the casting or on a tag affixed to the trap.

VALVES

Valves control the flow of fluids. They start, stop, direct, regulate, or throttle the volume and rate of flow of water, steam, and gases. There is no universal type of valve to accomplish all these purposes, but there are five basic designs generally found in schools. Each basic design has numerous modifications to meet special needs. Figures 32 through 39 illustrate the various valves and modifications found in schools. It is essential that the maintenance serviceman understand the mechanics of the particular valve under inspection or repair.

1) **Gate** valves provide tight shut-off. They offer little obstruction to the flow of fluids, have little turbulence through the valve, and therefore, have a very low pressure drop. They are used only in the wide open or full closed position. Three types of gate valves are shown in Figure 32.

2) **Globe** valves regulate or throttle the rate of flow (such as in a bypass around a pump regulator) or balance flow in several branch lines off a main line. Volume of flow is proportional to the turns of the handwheel.

A globe valve operates efficiently in any position, because it has a seating surface which minimizes seat erosion from the high velocity of fluid movement. (This erosion is called "wire drawing.") Figure 33 shows various types of globe valves.

3) **Butterfly** valves are used where both shut-off and throttling are needed with viscous fluids. They are not used on steam or gases. Since butter-

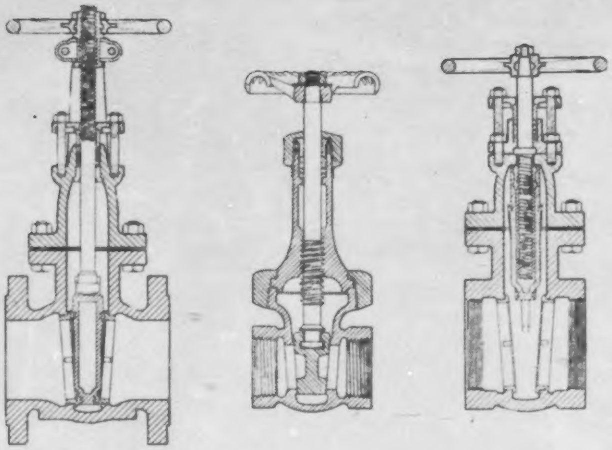


FIGURE 32—Gate valves. O S & Y stem design (left); inside screw, rising stem design (center); inside screw, non-rising stem design (right).

fly valves fit between companion flanges, they cannot be removed for repair without upstream shutoff unless double lug valves are provided. Figure 34 shows a typical butterfly valve.

4) Check valves are used to prevent the reversal of flow in a line. They represent safety or precautionary devices. The pressure of the flowing fluid keeps the valve open. The differential pressure on flow reversal closes the valve automatically, and tightness of seat depends upon how high the back pressure is. Figure 35 shows various types of check valves.

A special check valve often found in schools is the boiler stop-check valve. The valve shown in Figure 36 is a globe pattern, but the stop-check valve also is common in an angle pattern. It is a combination of a lift-check and globe valve. As shown in Figure 36 the stem is not attached to the disc, and is used only to close the valve when required for boiler testing.

5) Cocks and plug valves were probably the first valves known to man. Because of their simplicity and low cost, they find widespread use in shutting off or transferring water, oil, air, and gas. Figure 37 shows two common types.

VALVE MAINTENANCE AND CARE

With minimum maintenance effort, thousands of dollars in valve replacement can be saved each year. Most manual valves need to operate only in emergencies. A little care will ensure proper operation when desperately needed.

Leaking is the major problem encountered with valves. A valve can leak internally by not shutting off completely when required. More commonly, valves leak externally at various connections, such as where the pipe joins the valve or

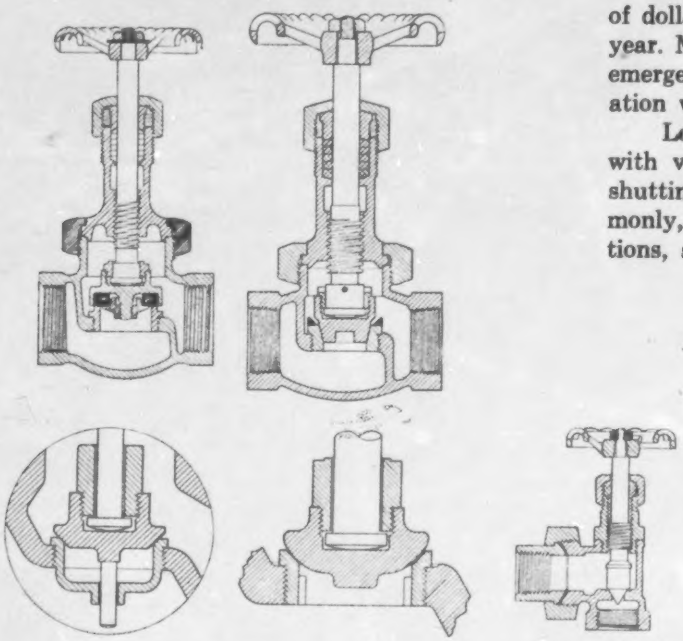


FIGURE 33—Globe valves. Bronze disc globe valve (top left) has disc that is easily replaced. Plug disc design (top right) is one of several similar popular designs. Narrow conical seat globe valves come in two designs. In one (lower left) the disc seating surface has the same angle as the body seat; in the other (lower center) the disc seating surface is curved. Needle valve (lower right) is also called an expansion valve.

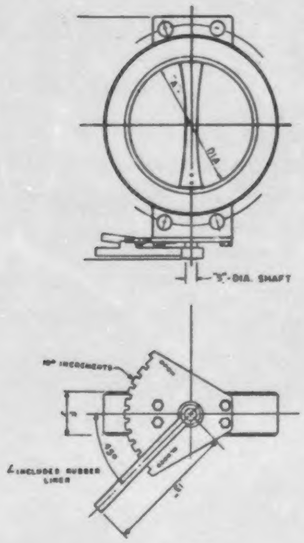


FIGURE 34—Butterfly valve.

flange, around the stuffing box, or where the body and bonnet connect. Frequent and regular inspection, therefore, is the best valve maintenance. When a leak is found, it should be corrected immediately, as time will only make it worse, not better.

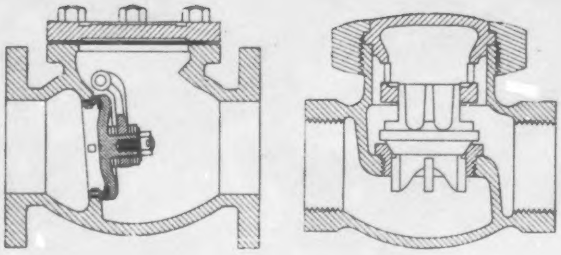
In most cases, external leaking can be corrected by tightening the flange bolts or stuffing box nut. Be sure to use the proper type and size wrenches to fit the job. Excessive torque at the wrong point can result in problems greater than the original leak. When tightening the packing gland nuts (hex nut just below the handwheel in Figure 32 - center, or bolts on top flange just below the handwheel in Figure 32 - right), the valve stem should be moved up and down a little first to free the stem from the packing material. Next, tighten down the stuffing box with enough pressure to make stem movement difficult. Then loosen the packing nut so it is free and tighten it down again only finger tight. Finally, move the stem up and down again and tighten further only as required to stop leaking.

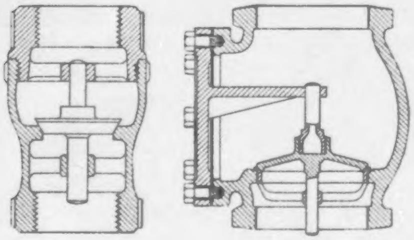
Caution: When opening a closed valve, do it slowly. Surge pressure or rapid temperature change can easily damage piping or equipment downstream of the valve.

If proper tightening fails to correct a leak, the only solution is to replace the flange gaskets or the stem packing.

Replacing Gaskets

The use of proper gaskets is the answer to maintaining tight flange joints. The gaskets must properly match the flanges and must be suitable for the fluid carried in the line. There are numerous types of flange faces used for as many different





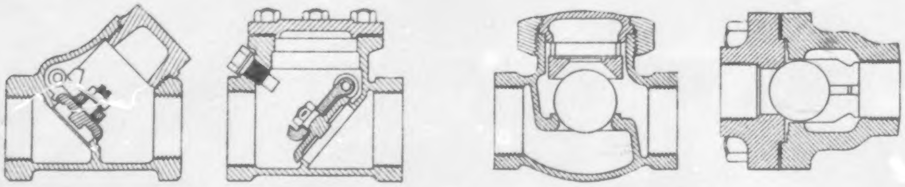


FIGURE 35—Check valves. Swing check valve (top left). Life check valve (top right). Vertical check valves include brass type (center left) and iron body (center right). The two small brass swing check valves (lower left) include a "Y" pattern and a regular pattern. The two ball check valves (lower right) are for horizontal lines only.

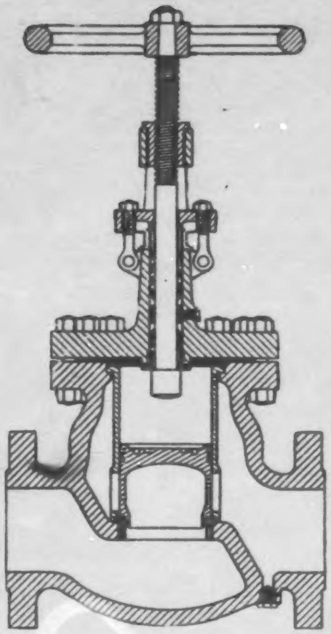


FIGURE 36—Stop-check valve is found in several patterns on school boilers.

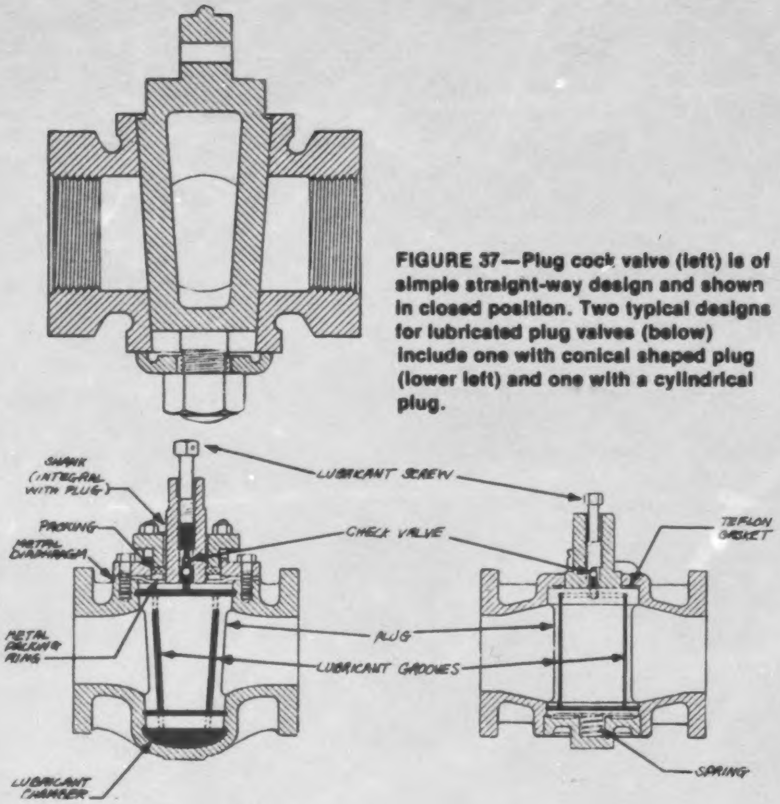


FIGURE 37—Plug cock valve (left) is of simple straight-way design and shown in closed position. Two typical designs for lubricated plug valves (below) include one with conical shaped plug (lower left) and one with a cylindrical plug.

applications. The gasket must match the type of flange face. (See Figure 38 for various types of flange faces and gaskets. Some of these are common in schools; some are not.)

Probably the most common type used in schools is the plain (flat) face flange used on brass, bronze, and 125-pound cast iron valves. The gaskets for these flanges should always be full faced and non-metal, because any gasket with an outside diameter less than that of the flange may produce excessive bolting load on the flange metal. With a narrow gasket, the flange has an open space beyond the outside edge of the gasket. This causes the flange to assume the functions of a cantilever (Figure 39). Non-metal gaskets are preferred for these conditions, because they require less unit loading to make a tight joint than do metal gaskets.

When opening or tightening the bolts on a flanged joint, the nuts directly across from each other should be loosened or tightened in sequence similar to the method used to tighten the lug nuts on an automobile wheel.

Before installing new gaskets be certain that the flange faces are thoroughly cleaned and polished and that the gasket is properly aligned on the flange face.

Questions about flanges or gaskets should be referred to the supply house or contractor.

Repacking Stuffing Boxes

A leaky stuffing box may be caused by a loose nut, worn out packing, or a corroded stem.

Most valves are designed with a back-seating arrangement that temporarily holds back the fluid while repacking. After the old packing is removed, check the valve stem to be sure it is smooth and polished. If it is pitted, probably no amount of stuffing box tightening will stop the leak. Thus, it is necessary to shut down and repair the valve.

The stuffing box must be cleaned before installing the new packing. The packing should be of material recommended for the service. The most common types are graphite string or ribbon or nylon or teflon in either ribbon or formed pieces. After the new packing is in place, tighten down the stuffing box nut and follow the procedure men-

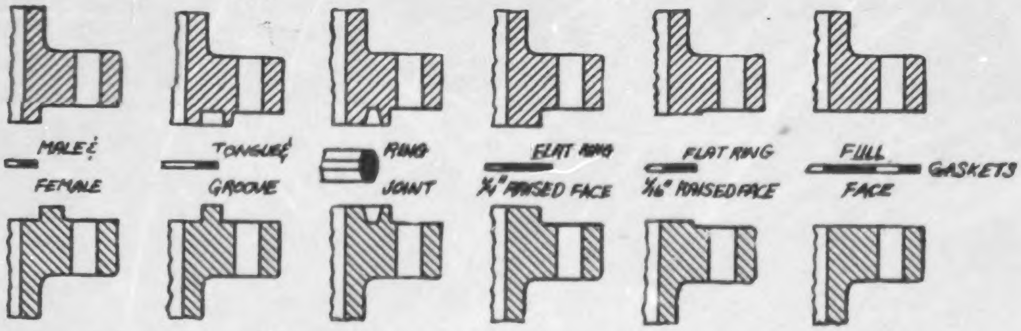


FIGURE 38—Flange facings come in several standard types with corresponding gaskets.

tioned earlier for tightening nuts in the proper sequence.

Replacing Worn Discs

When the valve does not shut off completely, the disc should be checked and replaced if worn. To check the disc, turn the stem to the closed position, open the bonnet joint where the stuffing box and stem assembly join the valve body, and lift out the entire assembly. Check the valve seat in the body for smoothness.

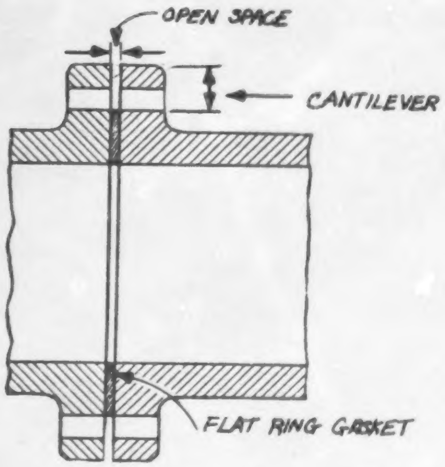


FIGURE 39—Narrow gasket shown here can produce undue stress on flange. Gaskets, therefore, should always cover the full face of the flange.

To replace the disc, remove the retaining nut and install the new disc. The disc must be of proper composition for the type and temperature of fluid. Note also that the stem is attached to the disc holder by means of a slight swivel. This action is required to allow the disc to properly seat.

Lubrication

Proper lubrication can prevent a number of valve problems. A routine schedule is best, but a haphazard program is better than none at all. Stem lubrication with a mixture of oil and graphite should be applied just above the stuffing box. The schedule required will depend on how often the valve is operated and what fluid it is controlling. A frozen valve stem indicates a lack of lubrication. Some valves have oil holes in the yoke cap, some have grease gun fittings, and others have stick lubricant chambers. Records of the various types, along with locations and code tags should be assembled as a means of scheduling inspections and maintenance. Such planning prevents delays in repairing valves and helps in stocking parts.

Any problem that appears to be beyond the scope of the maintenance team should be referred to the contractor, plumbing-heating supply house, or valve manufacturer.

Annual Inspection

Valves should be included in the annual inspection of the heating and ventilating system. See the Annual Inspection Checklist on pages 141 to 147.

UNIT HEATERS

A unit heater consists of a fan and motor, a heating element, an enclosure or cabinet, and a directional outlet. There are three main types of unit heaters: (1) Horizontal Propeller Fan, (2) Vertical Propeller Fan, (3) Cabinet Type Centrifugal Fan. The cabinet type unit may be arranged to deliver air horizontally or vertically.

The heating medium can be steam, hot water, gas, or electricity. If they become inoperative, gas fired (natural gas) and electric unit heaters should be serviced by either a qualified service organization or by the local utility company.

Unit heaters all operate on the same general principle. A room thermostat turns the motor on. The motor runs if the heating element is hot. When the thermostat is satisfied, it shuts the motor off. Some units are installed with a "summer-winter" switch mounted with the thermostat. When set in the summer position, the unit can be operated without the heating element being hot. This is used for air circulation when heat is not required. On steam or hot water units, a return line aquastat is wired in so that the motor will not run until the aquastat is satisfied. The "summer" switch cuts out this controller.

With gas fired unit heaters, the burner is ignited and the heat exchanger allowed to get hot before the fan motor comes on. When the room thermostat is satisfied, it shuts off the gas valve while the motor continues to run until the heat exchanger cools off. Then the motor is stopped. The electric unit heater operates in a similar manner in that the coil is turned on before the fan motor starts, and again is turned off before the fan motor is stopped. The table at lower left presents a suggested maintenance schedule for unit heaters.

GENERAL CLEANING

General cleaning is a most important factor in trouble-free and economical operation. The location of a unit is important to its cleaning schedule. A horizontal unit in a woodworking shop will require cleaning more often than will the same unit hanging in a clean storage room.

The heating element of a unit heater must be kept clean. The greatest amount of dirt, lint, sawdust, or other particles will be on the air entering side of the heating element. A good brushing will loosen most of this dirt. Do not remove a gas fired or electric heating element from a unit. Call a serviceman for this kind of work.

Inspect the fan for dirt. The fan can be cleaned by brushing; if very dirty, the fan can be washed but remove it from the motor shaft first. When replacing a fan on the motor shaft, or just inspecting it, pay particular attention to tightening the set screws. These screws should seat on the flat or keyway of the motor shaft.

After oiling the motor, wipe up all excess oil. This will help keep both the motor and the fan clean. Oil left on the motor rapidly collects an insulating coat of dirt, which causes the motor to heat up and shorten its life.

During general inspection, check the unit casing. Tighten loose nuts and bolts. Make sure electrical connections are tight and not rattling against the unit casing. If casing shows signs of rust, scrape the spots clean and retouch with paint.

The exterior surfaces of the unit should be cleaned the same as polished furniture.

FILTERS

Most cabinet unit heaters have a filter rack built into the cabinet. Filters are installed to take the dust, lint, and dirt out of the air before it enters the coil. A dirty filter, just like a dirty coil, greatly reduces the air delivery of a unit heater and, therefore, reduces the heating ability of the unit. Dirty filters and/or coils are the major cause of service calls complaining of "no heat."

LUBRICATION

Sleeve bearing motors are wool packed, oil lubricated bearings. SAE 20 grade oil is recommended for oiling these bearings. A few drops of oil about three times a year will keep these motors in fine running shape. *Do not over oil.* Wipe up all spillage. The cabinet type unit heater also uses sleeve bearings on the fan shaft. These bearings should be oiled at the same time with the same type oil. When oiling these units, be careful not to get any oil on the belt drive. If this should happen, wipe it up immediately.

Ball bearing motors should be greased about twice a year. Note that the plugs should be removed from the bottom of each bearing before supplying grease through a zerk fitting or grease plug. If the bottom plug is not removed, grease will be forced through the bearing into the motor winding. Remove surplus grease and replace grease plugs. Grease used on vertical unit heaters should be of the high temperature type recommended by the motor manufacturer.

UNIT VENTILATORS

Unit ventilators can heat, ventilate, or air condition. There are two kinds of unit ventilators: the standard type and the air conditioning type. The standard unit provides heating, ventilating, and natural atmospheric cooling, but it cannot be used for air conditioning. The air conditioning type can be used for heating, ventilating, and natural cooling, as well as for air conditioning.

A unit ventilator will heat an area to a desired temperature as called for by the room thermostat and will maintain that temperature by allowing outdoor air and/or recirculated room air to discharge into the room. This is done by means of dampers and/or valves. The required temperature is maintained by the room thermostat and an air stream thermostat. One works with the other to keep the discharge air coming out of the unit ventilator at such a temperature that the room air will remain at the constant temperature called for by the room thermostat.

At startup time in the morning, the discharge air coming out of the unit ventilator will be hot in order to bring the room air up to the desired temperature. As soon as the room is occupied, the temperature of the discharge air will go down to a point sufficient only to take care of the heat loss of the room. After the room has been occupied for a time, the discharge temperature generally drops below the thermostat setting, because the combined heat given off by the students, the lights, and the sun is more than the heat loss of the room. To maintain the desired temperature, it is therefore necessary to provide cooling by introducing outside air. This is done by means of dampers and/or valves in the unit ventilator.

HEATING SYSTEMS

There are four basic types of heating systems available for use with unit ventilators: steam, hot water, gas (direct fired), and electricity.

A steam unit ventilator is controlled by a valve on the heating coil supply line and damper motors on the outdoor air and return air dampers. The steam unit ventilator has a trap on the return line of the coil. This can be either a small thermostatic trap or a larger float and thermostatic trap.

Hot water unit ventilators are divided into two classes: valve controlled and damper controlled. The valve controlled unit has a supply valve similar to the steam unit. It also has a single damper motor operating the outdoor air and return air dampers. The control valve generally is a three-way valve that, when closed, bypasses water around the coil. The damper controlled unit generally does not have a control valve. It has a third damper inside the unit, which is called a bypass damper. The coil has water circulating through it at all times, and temperature control of the discharge air is accomplished by movement of the bypass damper. This allows the proper percentage of air to go through the coil while the balance of the air bypasses the coil. When mixed, this air is then at the proper temperature for the desired room condition.

If the building is designed for air conditioning and all necessary components are installed (which include air conditioning unit ventilators, chiller, cooling tower, etc.), the same damper controlled unit is used. However, it is insulated and a drain pan is factory installed in the unit along with a *larger* coil. Drain lines are installed in the building to drain the pans. When used for air conditioning chilled water is circulated rather than hot water.

Gas fired units are used when a central heating plant is not desired or available. Each unit is completely separate except for a common gas pipe. These units are equipped with outdoor air and return air dampers. Combustion air may come from the room or from an outside inlet. In some buildings, a unit is installed in each room; in other buildings, a small furnace room services two adjoining rooms. The operation and control is similar to the steam unit except that in place of the coil, there is a heat exchanger with a gas burner that goes on or off to maintain room temperature.

Electric unit ventilators are becoming more common. The basic operation is similar to the steam unit, except that an electric coil controlled by a step controller is used in place of a steam coil. The individual elements of the electric coil come on in steps. For partial heating, therefore, only part of the elements are used. These units also are equipped with outdoor air and return air dampers.

A preventive maintenance schedule for unit ventilators is presented in the table at left. The schedule should cover the following operations:

- General cleaning of equipment.
- Cleaning or replacing filters.
- Oiling and/or greasing motors and bearings.
- Miscellaneous cleaning and inspection.

FILTERS

Filters take dust and dirt out of the air before it enters the coil of the unit ventilator. Dirty filters greatly reduce air delivery and restrict the heating and cooling capacities of the unit.

A filter cleaning schedule should be based on experience for each room. A ground floor room near a playground area will require more changes or cleaning than will a similar room on an unused lawn area. Upper stories of a building generally do not require the frequency of service that is necessary for ground floor or basement rooms. A kindergarten room becomes loaded with lint more rapidly than any other room, due mainly to the rugs used by the small children. Filters become plugged more rapidly during the winter months than during the fall and spring seasons, because of lint from winter clothing. Therefore, individual room use, location, and season are the determining factors in the filter cleaning schedule.

Some unit ventilators use only one filter to clean all the air going through the unit. Other units have split filters, both in length and width. Large air handling units use a multitude of square filters. When the filter is long and very narrow, one filter is usually in a separate rack behind the other. If a filter is about six inches wide, there usually is another filter behind it. Do not miss cleaning or replacing this second filter.

There are three main types of filters available: the permanent type, the replaceable or throwaway type, and the renewable media filter.

A permanent filter has a metal frame with a crimped metal filter. To clean a permanent filter, immerse it in a scalding cleaning solution and move it up and down rapidly to wash out the dirt and old oil. A good cleaning solution can be made by dissolving 1½ pounds of washing soda in 10 gallons of hot water. If a cleaning tank is used, there should be a false louvered bottom to prevent stirring up the settled dirt on the bottom of the tank. After the filters are cleaned, they should drain dry. They must be sprayed thoroughly or dipped with filter oil until the filter is coated all the way through. After oiling, the filter is racked over a drain pan for at least 12 hours to allow the excess oil to drain off. It is advisable to have extra filter cells of all required sizes so that some can be cleaned while the others are in service.

Replaceable or throwaway filters are made of spun glass interiors with a cardboard frame. After this type of filter has become dirty, it should be thrown away and replaced with a new filter. Cleaning the surface with a brush or broom *does not* clean this filter, nor will pounding it get out enough dirt. Some dirt, of course, will come out, but the oils on the glass media have already been soaked up and dirt will now pass through this "cleaned" filter. Enough throwaway filters of all required sizes should be stocked to make sure clean ones are available.

Renewable media filters are a combination of the best features of permanent filters and replaceable filters. They have a metal suitcase-type frame and use spun glass for the filtering media. The renewable filtering media is purchased in a 75-foot roll of the desired width. This media is compressed in a box so that a roll of media is approximately a fourteen inch cube. The spun glass filtering media is pulled from the box and cut off to proper length with an ordinary pair of scissors. The media is pre-oiled so no further oiling is necessary.

LUBRICATION

Oil sleeve bearings twice a year using SAE 20 oil. Grease ball bearings once a year through the zerk fitting or plug on the outside of each bearing. Over greasing will force the lubricant through the bearing, where it may be picked up by the fan and discharged into the room.

Belt tension should be adjusted if required. The belt should be just tight enough so that it does not slip, but not so tight that it causes excessive strain on motor or fan shaft bearings. If the belt becomes frayed or noisy, it should be replaced at once. Do not try to tighten a loose belt by closing the adjustable motor sheave. This will speed up the fans and cause noise.

INSPECTION

Some unit ventilators are furnished with a separate fusetron in the unit switch box, or it may be found in a separate box near the electrical outlet box in the unit. The types and sizes of these fuses should be recorded and a small quantity of each size and type should be stocked.

If belt drive units are used, the belt sizes should be recorded and at least one of each size should be stocked. A belt that has remained in one position for some time may develop a hump and become noisy. For this reason, during extended shutdown periods, it is well to run all belt drive units once a month for a few minutes. This is especially important if the belt is very tight. Make sure that no oil from the motors or bearings gets on the belt. If it does, wipe it off immediately. Oil will ruin a belt.

If direct drive units are installed, couplings and bearings could be required. Since any given manufacturer standardizes on these items, all couplings and bearings in a classroom unit are identical on all size units of one manufacturer. Two of each should be stocked.

All unit ventilators use some type of special wrench, key, or screw driver fastener to keep them tamperproof. It is recommended that two complete sets of these tools and fasteners be obtained, one set for the head custodian and one set for the school's administrative office. If the custodian is not available, the office set will be available for emergency use. These special tools may be obtained directly from the unit manufacturer.

Do not, under any circumstances, try to oil the damper motors, valve stems or thermostats. If there is a malfunction in these parts, call the temperature control serviceman.

RECORDS

A complete set of records should be kept on each unit ventilator. If the building is comparatively new, obtain a set of "shop drawings" from the architect or heating contractor. These drawings give all pertinent information on each unit by room number. If "shop drawings" are not available, most manufacturers can furnish a file print for each unit — if the building is not too old. The only other alternative is to take a physical inventory and record the following:

Manufacturer __________
Model Number __________
Serial Number __________
Current __________
Motor Shaft Sizes __________
Bearing Size __________
Outside Service Information __________
Room Number __________
Date Installed __________
Belt Size __________
Motor Frame Number __________
Fan __________
Fuses __________
Coupling Size __________

Energy Conservation

Unit ventilators will waste large amounts of energy if their controls and components allow more outside air than necessary into the building. The units should be checked and adjusted at least annually to insure proper control and minimize energy consumption.

AIR HANDLING UNITS

An air handling unit generally consists of a centrifugal fan, heating and/or cooling coils, filter box, fan motor, and belt drive. It may be controlled by cycling the fan from the thermostat or the fan may run continuously with air volume modulated by face and bypass dampers or a valve control on the heating/cooling medium. The fan selection may discharge into conventional ductwork or into a plenum with grilles.

The table at right presents a suggested schedule of preventive maintenance for air handling units.

Spare belts should be stocked. If drives use multiple belts, the belts should be stocked in matched sets and the complete set of belts replaced at one time. If belt life is shorter than expected, recheck alignment and tension. It is normal for belts to squeal on startup; do not overtighten just to eliminate this initial squealing.

When checking or servicing motors, drives, or fan wheels, be sure the motor disconnect is open and tagged so other personnel will not restart the unit. Be careful near belt drives when belt guard is removed for service. Do not wear loose clothing or ties when working near exposed drives.

Air handling units often draw in large quantities of outside air. The amount of outside air depends upon the adjustment and alignment of the outside air dampers. Insure that these dampers close and seat properly, so that excess outside air quantities are not heated and cooled due to improper damper adjustment or leakage.

ROOFTOP AIR CONDITIONING

Rooftop air conditioning equipment consists of a complete package containing both heating and cooling facilities. The package may be a single-zone system serving only one area, or a multi-zone system serving several areas at the same time. The major cooling components are the refrigeration compressor, evaporator or cooling coil, and air cooled condenser coil. The heating sections vary depending upon the heat source -- gas, oil, or electricity. Some units may use hot water or steam piped from a central boiler.

Each manufacturer has specific instructions on how to adjust and care for the various components of their equipment. Special tools and training are necessary in order to make certain repairs and to perform certain maintenance checks. However, most of the important checks and maintenance services should be made regularly by the school maintenance team. All that is required is alertness during specific routine inspections. The Maintenance Checklist for Rooftop Air Conditioning on pages 125 and 126 of the Management Tools Appendix will help in scheduling and carrying out the maintenance program. The following is what can and should be done on a routine basis.

WEEKLY

Allow about 15 minutes to inspect each unit as follows:

1) **Check the room thermostats** to make sure they respond to the call for heating or cooling, and that they maintain the set point temperature. Replace or calibrate thermostats as necessary.

2) **Observe operation of all fans** on the rooftop unit. Some units have three fan sections for supply air, return air, and condenser.

- Listen for fan noise. Most fan noise will be the result of worn or defective belts or bearings. Fan belts should slip on start-up for approximately 30 seconds. If they continue to slip after the motor comes up to speed the belts or pulleys need to be checked.
- Fan vibration also may be due to out-of-balance. Check fan wheels to make sure they are free of debris.

3) **Observe the evaporator coil section.**

- Make sure all filters are clean and in place.
- Look at fan inlets to be sure nothing is blocking air flow; sometimes loose insulation or paper will find its way into the inlet.
- Observe the refrigerant sight glass. It should be clear and free of bubbles.
- Check to make sure the drain in the pan below the coil is free and draining condensate.

4) **Observe the condenser coil section**

- Make sure that the fan discharge protection guards are in place and that there are no sticks, wires, or the like lodged in the guards which could strike the fan blades.
- Check fan blades for damage.
- Check the coil face for dirt, leaves, etc. This is especially important when cottonwood or sycamore trees are shedding. This shedding will quickly plug a condenser.

5) **Observe the refrigeration compressor.**

- Check the oil sight glass. Oil should be visible in the glass, but not necessarily full; this level will change depending on unit load.
- When the compressor is running, the suction side should be cool to the touch and may be sweating. If it is warm or if there is ice on the suction line, then something is wrong.
- Do not touch the discharge line;

this often will run quite hot and could cause a painful burn.

- Observe the compressor to make sure it is not short cycling. If it starts and stops more than once every 15 minutes, something is wrong.
- Observe refrigerant piping for obvious leaks. A bad leak leaves an oil residue around the piping.
- Inspect the compressor electrical control panel. Listen to make sure contactors are not chattering. Look for moisture which might get in through leaking door gaskets. Observe the condition of control wires. If wires are loose, they will overheat. *Do not touch any wires or controls while panel is energized.*

6) **Observe the heating section.**

- Check the flue vent on oil and gas fired units to make sure they are not blocked or rusted out. Excessive carbon in this area indicates improper burner adjustment.
- Check the burner section on oil and gas fired units to make sure there is no evidence of flame leakage in this area. This could result if the burner door gaskets are leaking or if the burner is not properly adjusted.
- Listen to burner operation. The flame ignition should be smooth. Rumbling or loping indicates improper burner adjustment. Delayed ignition will result in a noisy light off. Delay also indicates a need for burner adjustment.
- Examine the electrical control panel on units with electric heat. Listen for chattering heating contactors on each heater. Watch for short cycling which will be evident by a heating relay pulling in and out every few seconds. Look for loose wires in the panel. This will be evident by wires which appear to be burned. *Do not touch any wires or controls while panel is energized.*

MONTHLY

Allow about 30 minutes to inspect each unit, as follows:

1) Adjust fan belts on all fans.

2) Clean or change filter as necessary.

3) Clean evaporator coil if necessary. This will probably be necessary only once a year, depending on filter maintenance. Do this with a brush and vacuum cleaner, or a hose and cold water. *Do not use hot water.*

4) Clean the condenser coil. If necessary, do this two or three times during the cooling season. This will depend on the area and how many seed-shedding trees are nearby. If there are many units, it will save money to purchase a portable high pressure washer with a fine spray attachment. These are used with a mild soap solution and will cut cleaning time by about 25 percent. Wash coils in the direction of flow as well as in the opposite direction of flow. *Do not use hot water.*

ANNUAL

Allow about 30 minutes for each unit.

1) Replace all fan belts. *Do not roll new belts over sheaves.* Loosen the adjusting bracket so the belt can be slipped into place.

2) Check fan belt sheaves. If sheaves are grooved, replace them. Worn sheaves will lead to early belt failure and could cause bearing failure and fan damage.

3) Lubricate all fan bearings and fan motor bearings as recommended by the manufacturer. *Do not over grease. Remember, more bearings fail from over greasing than from not enough grease.*

4) Check all damper linkages and tighten as necessary.

5) Check all panel doors for loose gaskets. Replace and repair them as necessary.

6) Caulk any seams or screw heads with silicone sealant to assure a water tight seal.

7) Check insulation on the interior panels to make sure it is tight. Reglue or replace as necessary.

8) At the startup of the heating and cooling seasons, it is recommended that the manufacturer's service representative be called in to tune the heating and cooling units for maximum efficiency. This requires special tools, testing equipment, and knowledge. Contact the manufacturer for advice. If the school maintenance team has the necessary expertise, the manufacturer's operation and maintenance manuals will list the proper settings for all operating and safety controls.

Rooftop air conditioning also should be included in the annual inspection of the heating and ventilating system. See the Annual Inspection Checklist on pages 141 to 147.

SAFETY

Servicing rooftop units may be difficult, because they are located in an area where the serviceman is exposed to the worst of the elements. Service is usually required when the conditions are adverse. Wintertime requires bulky clothing and restricts movement, and roofs are often covered with ice. Care must be taken to avoid getting clothing caught in fans and to avoid slipping and falling into an electric panel. To minimize danger:

1) Make sure the ladder or roof access is safe and free from ice.
2) Place a catwalk around the unit where service personnel are working to keep them out of the ice and water.
3) Always use plastic or rubber covered handles on tools to avoid electrical shocks.
4) Never work on fans with the power on.
5) Never pry belts on over sheaves. It could injure a finger.
6) Never reset a safety control more than once without determining the cause. Repeated resetting can damage the equipment, and can result in personal injury as well.
7) Always latch panels open when working inside a panel. A sudden burst of wind can cause a panel to slam shut knocking the serviceman into the electrical controls.

Ecology

There is a certain amount of unavoidable noise inherent in the operation of rooftop equipment; however, unnecessary noise can be avoided if fan bearings are properly maintained and fan belts properly adjusted. Unnecessary noise of unit cycling can be avoided if controls are properly set and maintained. To some, rooftop units are unsightly. They stick out all over the roof of a beautiful building. It helps if the units are kept painted to blend with the background and if bent or loose panels are immediately repaired. Proper burner adjustment avoids heat discoloration and rusting of flue stacks.

Energy

Pre-packaged rooftop units are probably more efficient than systems assembled in the field. The package concept gives factory engineers more control over the total system, including an opportunity to avoid some of the inefficiency which can creep into field assembled systems. For example, packaging allows closer sizing of fans, compressors, and motors. To maintain peak efficiency, however, good maintenance is required. The rooftop design concept allows the school maintenance team to perform most of the maintenance, but the complexity of troubleshooting may be beyond the capability of local service people. If so, consult the manufacturer.

TEMPERATURE CONTROLS

The heating and/or cooling system installed in a school building is designed to maintain comfortable inside temperatures during severe outside conditions (summer or winter). A temperature control system – electric, electronic, or pneumatic – is installed to maintain satisfactory conditions within the building regardless of outside conditions. A properly maintained control system holds the energy consumption (heating or cooling) to the lowest possible level for any given outside conditions. Conversely, a malfunctioning control system, in addition to not maintaining comfortable inside temperatures, will waste fuel and energy.

In order to properly maintain the temperature control system, the maintenance team must understand the particular system and the various mechanical devices which the system controls. Information regarding the building can usually be obtained from the consulting engineer or equipment suppliers. Once it is understood how the system was designed to work, it will be much easier to spot trouble and maintain the system properly.

A preventive maintenance schedule will reduce system failure. The suggested items below are general; consult a temperature control representative for additional information which may be pertinent to a particular system.

Here is a suggested routine maintenance schedule for a pneumatic control system:

WEEKLY

1) **Air Compressor Storage Tank.** Accumulated dirt, oil, and water in the storage tank must be eliminated periodically. If the system does not have an automatic drain trap, blow off the tank through the pet cock or drain plug at the bottom at least once a week.

2) **Air Compressor Air Filter.** Inspect filter media and, if equipped with a pet cock at the bottom, drain when draining tank.

3) **Air Pressure Reducing Valves.** Make a visual inspection of air pressure gages associated with system air pressure to ascertain correct system pressure. If the system incorporates a day-night system, check for proper changeover to night pressure.

MONTHLY

1) **Oil Level.** Check the oil level in the air compressor and add a good grade of No. 20 motor oil as necessary. Caution: Do not fill above the specified level.

2) **V-Belt Drive.** Adjust tension after the first month of operation. Avoid excessive belt tightness, which overloads bearings. Correctly adjusted belt permits an inch or so of flexing between pulleys. If the belt is worn, replace it with a new one. An extra belt will limit system down time.

3) **Running Time.** Most systems are designed for 50 percent running time: i.e., it will remain off as long as it runs. Average storage capacity will produce about three minutes on and three minutes off, although each installation may vary considerably from this generality. By checking periodically, the norm for a particular system may be determined. Any faster sequence would bear investigation into such items as ruptured diaphragms or airlines.

4) **Refrigerated Aftercooler.** If the system incorporates an aftercooler, check to see that moisture is being removed from control air. Check the evaporative condenser coil for build-up of dust and dirt. An accumulation of dirt will affect capacity. Clean and check the automatic drain and traps to assure removal of moisture. Clean and check all filters, etc., to assure removal of oil from the system. If moisture and/or oil show up in the system, it is imperative that service be obtained to check the instrument air system and avoid damage to controls.

SEMI-ANNUALLY

1) **Air Compressor Suction Filter.** Clean the suction filter every six months.

2) Air Compressor Motor. Check oil every six months or as recommended on the motor name plate, if the motor does not have permanently lubricated bearings.

3) Air Compressor Pop Safety Valve. Check the blow off pop valves every six months to insure against sticking.

4) Air Compressor Pump. Drain and refill crankcase oil.

ANNUALLY

1) Automatic Dampers. Check dampers once a year (or oftener in localities where the air is especially dirty or contaminated). Clean pivots of dirt or other foreign matter and see that they operate freely. Clean any rust or corrosion from the damper blades and repaint. See that linkage operates freely, and check that motor operator is properly secured to the damper shaft.

2) Damper Operators. Clean the piston operator stems. Do not lubricate the stem. Check the motor operator for diaphragm leaks.

3) Automatic Valves.

- Check packing adjustment once a year or oftener if necessary. Tighten packing only enough to prevent leaks; hand tight is sufficient on most low pressure systems. Where righter adjustment is necessary, turn nut with wrench enough to stop leak, then loosen one-eighth turn. Where available, adjust stem lubricators to lubricate valve stem.
- Check for leakage through the valves when valve is fully closed. Replace discs if leakage is detected. Recheck if leakage persists; refacing or replacement of valve seat may be necessary.
- Recalibrate all room thermostats and controllers. Prior to heating the system, check the operation of all low limit detection thermostats to be sure of proper sequence of operation when low temperatures exist.
- Check each relay for proper setting and operation.

A typical checklist used in the routine inspection of temperature controls is presented on page 127 of Management Tools Appendix. Inspection of controls also should be included in the annual inspection of the entire heating and ventilating system. (See pages 141 to 147 of Annual Inspection Checklists.)

Should problems arise, several items should be checked before calling a serviceman. The more one knows about a system, the better one will be at determining the real source of trouble. Remember, the room thermostat in itself does not produce the heating or cooling for the room; it only controls it. Check first to see that the heating or cooling unit is operable before calling the temperature control serviceman. Also inspect air filters in unit ventilators and air handling systems. If clogged filters reduce the amount of heated air provided to an area, the thermostat cannot do anything about it. Routine inspection and replacement of filters is essential.

ENERGY CONSERVATION

By design, the automatic temperature control system is an energy conserving system. Properly maintained and used, the control system will provide the desired environmental conditions at minimum utility costs. It is important to understand a particular system in order to capitalize on its energy conserving features.

The following energy saving possibilities should be investigated and, if possible, incorporated into the energy conservation plan.

- **Probably the most** obvious method of conservation, reduction of room temperature, will certainly reduce energy consumption. Advising building occupants of this action will allow proper dress and reduce complaints. Should the building be equipped with air conditioning, the same principle applies in reverse – raising the space temperature several degrees will save energy.
- **If the system incorporates** a day-night or occupied-unoccupied cycle, possible savings may be obtained by lowering the night or unoccupied setting and adjusting the changeover time to bring the system up to temperature later. Also, change to night or unoccupied cycle earlier. Experimentation may be necessary to produce optimum results.
- **Improperly calibrated controls** can have a disastrous effect on any energy conservation efforts. Cycling controls, in addition to causing undue wear on control components, result in staggering energy losses. Many times these losses are compensated for within the system and often are unnoticed by building occupants. While much can be accomplished in the area of energy conservation by using common sense, it would be wise to review specific plans with a qualified consultant to be sure the plan is technically sound.

Sanitary Systems and Fixtures

FAUCETS

Most faucet valves have hard rubber or composition gaskets which wear out, as evidenced by water dripping from the faucet. Where gasket replacement is needed, the branch supply valve should first be closed. The handle assembly should be removed by unscrewing the union nut and turning the handle counterclockwise until it is freed from its channel. The old gasket should be removed from the bushing by taking out the holding screw and a new gasket placed on the shaft. Then reinsert the screw and tighten. The bushing and valve seat should be checked for scars or erosion which could cause a leak.

WATER CLOSETS

Water closets operate by releasing water from a tank or from the supply line by means of a flushometer valve.

Tank Type

The tank-type water closet has a reservoir mounted on or above the back of the fixture. Water is released from this reservoir to flush the water closet by moving a handle, which lifts a rubber ball from its seat on the discharge pipe. As the water level in the reservoir recedes, a float falls and opens a supply valve. The tank has an overflow pipe to prevent flooding in case the supply valve sticks open. A constant discharge of water through this overflow may require bending the float rod to lower the water level. If the float itself is waterlogged, however, it should be replaced. If a leaking plunger valve is causing the discharge of water, then the thumbscrew should be removed from the valve, the rod level taken out, and the plunger removed. The washer at the end of the plunger should be replaced and the valve seat checked and reground if it is cut or scored. Then the assembly should be replaced.

Floats sometimes become waterlogged because of punctures or leaks around their threads. This prevents their rising as the water level in the tank rises and causes the intake valve to remain open, permitting a continuous flow of water into the tank.

Flush balls are usually made of rubber, are spherical, and have a lift rod screwed into one end. The purpose of the flush ball is to seal the discharge pipe after flushing so that the tank will be refilled.

Both the flush ball and the float can be replaced with new ones by simply unscrewing them from their respective rods and screwing on new parts.

Flushometer Valves

Flushometer valves depend upon water volume and pressure for operation. These are metering valves which complete their cycle and shut off automatically. There are two basic designs of flush valves – the diaphragm type and the piston type. The theory of operation of each is fundamentally the same. Each has an upper chamber and a lower chamber connected by a bypass, which is a small hole no larger than a pinhole. In the diaphragm type, the separation between the two chambers is by a flexible diaphragm; in the piston type, a piston with a molded cup separates the two chambers.

With either type, when the handle of the valve is moved, pressure is released from one chamber, thereby opening the water line and allowing water to flow into the fixture with sufficient force to flush and cleanse it. While water is flowing from the supply line, a small amount passes through the tiny hole to re-establish pressure in the other chamber, causing the valve to close and shut off the flow of water.

Generally, the only maintenance required for the flushometer valve is to keep it clean, especially the tiny opening between the two chambers. Gaskets, washers, and other rubber or plastic parts wear out and have to be replaced occasionally. Also, in the diaphragm type, the diaphragm has to be replaced every three or four years.

URINALS

Some urinals operate by means of a flushometer valve similar to those described for water closets. Others use an automatic flush tank, consisting of a tank mounted on the wall (or concealed between walls) above the urinal with a siphon, or upsidedown U-shaped tube, leading from the tank to the urinal. The siphon discharges water from the tank to flush the urinal as frequently as water fills the tank to a predetermined level. The water supply line to the tank has a throttling valve to control the frequency of flushings by controlling the speed with which water fills the tank.

Siphons sometimes develop leaks, causing loss of air. These must be stopped, because loss of air from the siphon tube will cause it to stop functioning.

SHOWERS

Shower heads require little maintenance other than occasional cleaning to remove mineral deposits.

Shower valves fall into four classifications: the "two valve" type, the "mixing valve," the "thermostatic valve" and the "master control valve."

The *two valve* shower consists of two valves constructed similar to a faucet. The valves have composition gaskets and seats which wear out and cause the shower head to drip.

The *mixing valve* consists of a single lever valve which controls the temperature of the shower water. A sudden reduction in either the hot or cold water supply pressure (usually cold water because of flushing water closets) causes an uncomfortable change in the water temperature. This problem is almost entirely eliminated in the "balanced pressure mixing valve."

The *thermostatic valve* controls the water temperature by a heat sensing element, which in turn moves the hot and cold mixing parts of the valve. These valves are normally provided with a strainer on the hot and cold inlet supplies to remove any sand, grit, or other substance which may be present in the water mains. The strainers should be cleaned at the first indication of slow response to water temperature variation or if pressure variation is noticeable.

The *master control system* consists of a thermostatic controller that maintains a preset tempered water to all hand washing or shower areas. With this system, cold water is not normally provided to the fixtures. These valves, similar in operation and construction to the thermostatic mixing valve, should have the strainer cleaned monthly.

WASHFOUNTAINS

Washfountains come in a variety of materials and sizes, ranging from semicircular to circular and from free-standing to wall-hung and are foot or hand operated.

Periodic cleaning of the spray head is recommended. Frequency depends upon the mineral content of the water. To clean, remove the wing or hex nuts, drop the lower spray-head ring and clean out chips and other foreign material with a wire brush. Lime build-up can also be removed in this manner.

If there is a fluctuation in the water temperature the following procedure should be followed:

Manual mixing valve — If temperature fluctuates, or only one temperature of water is delivered, the check valves may be at fault. Trace the supplies beyond the check valve to see whether hot water is entering the cold line, or vice versa. Supply lines of too small diameter may cause this problem by drawing hot water past the check when a flush valve is operated, causing a drop in pressure in the cold water line.

Thermostatic mixing valve – Most thermostatic valve repair involves changing the slip ring and power element. Usually these operations will eliminate temperature fluctuations. Disassemble valve top, spring, main valve slide and power element. Handle power element cautiously so as not to damage.

Take a pocket knife or some pointed object and remove old flip ring. Insert a new flip ring into the recess or channel. Install the power element. Apply grease to the main valve slide and gently ease it into position. Rotate the slide so grease is applied to the flip ring. Do not force as this could push the ring out of its socket. To test, rotate the slide and if it is properly in position, a slight drag will be felt. Reassemble the remainder of the valve.

If no hot water is available, check the source of supply for corrosion which may have closed the supply line.

To prevent foreign matter from getting into the thermostatic valve and causing problems, it is often protected by a strainer check stop. Shut off the screwdriver stop, remove and clean the strainer and inspect the check for smooth operation.

The introduction of acids, alkaline cleaning solutions, and other destructive cleaning agents into precast washfountain bowls can cause deterioration of the bowl surface.

COLUMN SHOWERS

The shower control may be a manual "two valve" arrangement, a pushbutton metering shower valve, or a pressure balancing mixing valve.

Any leakage around the shower head may indicate a hole in a control valve. Because there are usually from three to six shower stations at each column, this will require checking each valve.

Shower head cleaning — If the shower head delivers an uneven spray, remove and disassemble it and remove foreign matter.

Shower drain cleaning – The drain can be cleaned with a plumbers snake inserted through the hand hole of the column.

The angle of the shower head spray pattern may be adjusted up to 15° by loosening the shower head lock nut and bending the supply pipe.

Two Valve Control

The "two valve" controls may be repaired by replacing the valve seats and washers similar to other faucets. Either tighten the bonnet or replace the packing ring to eliminate leaking around the valve handle.

Metering Valve

If the column showers are provided with a pushbutton metering valve, it would simplify the service or repair of the valve to have two or three spare cartridge units available.

The time cycle of the metering shower may be changed by removing the plug button on the push knob, loosening the Allen set screw of the push knob, and adjusting the travel distance with a thin blade screwdriver in the center hole of the push knob. Turn the push knob while holding the screwdriver firmly. Turn knob clockwise to shorten the shower cycle and counterclockwise to lengthen the cycle.

Balanced Pressure Valve

The terms "pressure balancing" or "balanced pressure" indicate the valve is provided with a floating or free-moving piston which equalizes pressures between the hot and cold water supplies. The cold water usually varies the most because of the operation of flush valves on urinals and waterclosets. When operating properly, the hot water will not flow if the cold water supply to the valve is shut off, thereby reducing the possibility of scalding bathers.

To service the pressure balancing valve, first open it to about the warm position. Then loosen the handle screw and remove the handle. Remove the escutcheon, unscrew the dial lock nut and remove the dome cover. Unscrew the valve cap with the complete assembly.

Leave the packing nut in place while unscrewing the cap to avoid distorting the end of the cap. When the cap is unscrewed, the entire working unit may be removed.

The perforated cylinder is an integral part of the spindle and it does not unscrew. The cylinder is hollow and contains a piston: The piston is free moving and provides the pressure-balancing feature of the valve.

The piston should move freely inside the cylinder at all times, and should click back and forth when the assembly is shaken. After long service in "rugged" waters, mineral or other deposits may block the piston's action.

Normally, tapping the handle end of the spindle against a solid object will free the piston. If it is so solidly plugged that this is not effective, replace the entire spindle assembly.

Ordinary service requires only the replacement of hot and cold washers. It is essential that both hot and cold washers be replaced at the same time, even if only one appears to require attention. Use only pressure balancing valve washers.

When reassembling the valve after any repairs, be sure that the cylinder is drawn close to the cap before screwing the cap back into position.

DRINKING FOUNTAINS

Drinking fountains are manufactured from several different materials with the most common being vitreous china and enameled cast iron. They may be surface mounted, semi-recessed, or fully recessed.

All three types are provided with a stop fitting, usually screwdriver operated, which is used to shut off the flow of water to the fountain and to adjust the height of the bubbler stream. The adjustment is made from below on all but the fully-recessed type, which has an access cover plate on the front.

The bubbler is controlled from a self-closing valve, which is either a spring return handle push-button or foot pedal. The latter operates by compressing a spring and a washer and seat. The most common type of bubbler operator is a compressed spring that keeps pressure against two cams separated by a ball race or ball bearings. As the handle is turned, the cams operate against each other with the aid of the bearing, opening and closing the valve against the seat.

The bubbler height should be adjusted so the stream arches up above the bubbler saliva guard so that the mouth of the user need not touch the guard.

ELECTRIC WATER COOLERS

Electric water coolers consist of a self-contained air cooled condensing unit. This refrigeration unit cools the water to approximately 50°F., which is considered the desirable drinking water temperature.

Adjustment of the bubbler stream usually requires the removal of the valve handle (which is secured to the valve by an Allen-type set screw) and unscrewing the bubbler stream nozzle. The bubbler saliva guard can then be removed and the stream height adjusted as follows:

Reconnect the stream nozzle, without the saliva guard and valve housing. An adjustable pressure regulator is a part of the bubbler valve and has a screwdriver adjustment for regulating the pressure (stream height).

Keep in mind that many times the bubbler stream can be adjusted by adjusting the supply stop. However, if water pressure exceeds 50 psi, adjust pressure through the regulating valve, as excessive pressure will wear the stops.

Some electric water coolers feature "pre-cooling." This is accomplished by coiling the waterline to the bubbler around the drain pipe in order to "pre-cool" the drinking water.

A remote water cooler is a term used for condensing units that are not housed within the drinking fountain enclosure. Units of this type pipe the chilled water from the refrigeration unit to a drinking fountain as previously described. It is important that the piping between the remote cooler and the drinking fountain be well insulated to maintain the desired water temperature, to prevent excessive operation of the remote unit, and to prevent the water in the atmosphere from condensing on the cold pipe and dripping.

Other than making sure that dust and dirt do not accumulate within the cabinet, which reduces cooling efficiency, little maintenance is required.

The foot pedal operation is normally by a series of rods and springs and levers which connect to the hand valve. Maintenance requirements are limited to adjustments and replacement of a spring or rod.

Sewage Treatment Plants

The sewage treatment plant must be given regular and proper attention. It is a substitute for municipal sanitary sewers and sewage treatment plants.

Proper maintenance and operation are necessary. Neglect or improper maintenance may necessitate complete reconstruction of the plant in a relatively short time. Objectionable odors and unsanitary conditions will result from improper operation.

Almost all private sewage treatment plants fall into one of two types – those using a "Septic Tank" or those using "Extended Aeration." All sewage treatment plants must be installed and operated in strict accordance with the requirements of the Environmental Protection Agency.

Septic Tanks

A septic tank removes solids from sewage. (Figure 40) These solids settle to the bottom and form sludge. Heavy scum forms on top of the liquid.

Maintenance

Inspect septic tanks at least twice per year. Check baffles or pipe fittings. They should be in place at inlet and outlet. These baffles or pipe fittings prevent scum and solids from entering the outlet sewer and prevent currents across the tank.

Cleaning

When total depth of scum and sludge exceeds one-third the liquid depth, it must be cleaned. Frequency of cleaning depends upon the size of the tank and the daily flow. Garbage disposals increase cleaning frequency. No chemical or digesting yeast will completely clean a septic tank. Sludge can be removed only by special cleaning equipment. Call the health department for help in obtaining this service.

Following is a section from the "Manual of Septic Tank Practice" as published by the U.S. Department of Health, Education and Welfare:

> "Chemicals. — The functional operation of septic tanks is not improved by the addition of disinfectants or other chemicals. In general, the addition of chemicals to a septic tank is not recommended. Small amounts of chlorine bleaches, added ahead of the tank, may be used for odor control and will have no adverse effects. Small quantities of lye or caustics normally used in the home, added to plumbing fixtures is not objectionable as far as operation of the tank is concerned. If the septic tanks are as large as herein recommended, dilution of the lye or caustics in the tank will be enough to overcome any harmful effects that might otherwise occur.
>
> "Soaps, detergents, bleaches, drain cleaners, or other material, as normally used in the household, will have no appreciable adverse effect on the system. However, as both the soil and essential organisms might be susceptible to large doses of chemicals and disinfectants, moderation should be the rule. Advice of responsible officials should be sought before chemicals arising from a hobby or home industry are discharged into the systems."

DOSING CHAMBER

Sewage drains from the septic tank and accumulates in the dosing chamber, then a siphon automatically discharges sewage onto one of the filter beds. (Figure 41) Siphons flood the sewage onto the filters and distribute it over the entire

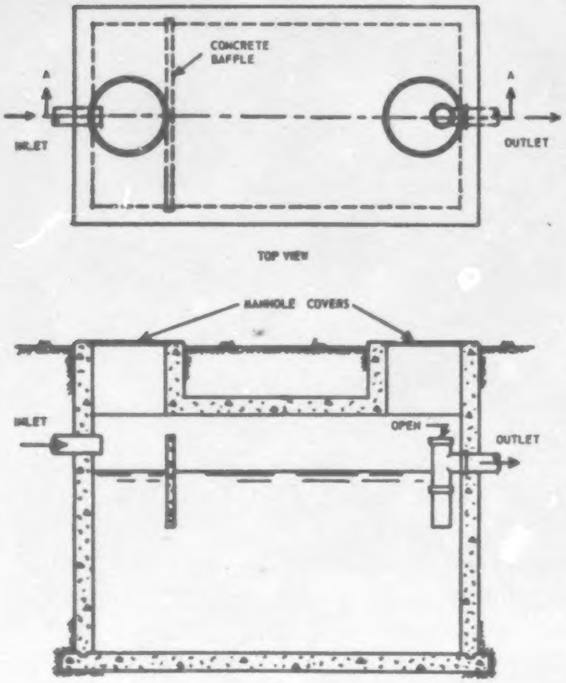


FIGURE 40—Septic tank.

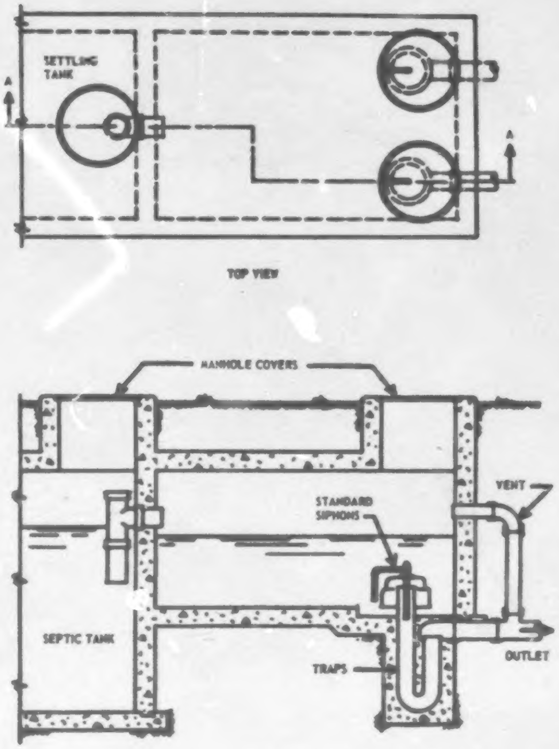


FIGURE 41—Dosing chamber with alternating siphons.

surface of the beds. There may be one or two siphons in the dosing chamber.

If there are two siphons that work alternately, one siphon discharges at the first filling of the chamber, the other siphon discharges at the second filling.

Inspection

Inspect siphon operation at least twice each week. The dosing chamber must fill to a level about three inches below the overflow pipe and then empty rapidly. Otherwise, siphons are not operating properly.

Siphons must operate automatically and alternately. They should discharge from one to four times daily depending on the flow.

Operation for Starting Siphon

1) Remove the bells.
2) Make certain the main traps are clean.
3) Fill the traps of both siphons with water.
4) Make certain bells are replaced tightly on traps to prevent the escape of air.

Check Traps

1) The idle trap may refill when the other siphon operates. There are several possible causes:
   - A leak in the floor or discharge line.
   - Backing up of sewage into the discharge line from the manhole or filter beds.
   - Clogged discharge line.
2) Make certain the outlet from each siphon is free.

Pump Chamber

Sometimes alternating pumps are substituted for siphons in a wet well. (Figure 42) Dual pumps are operated alternately by a float-controlled automatic switch. The pump chamber requires the following service:

Pumps and Motors

1) Follow manufacturer's lubrication instructions.
2) Allow good ventilation for motors to prevent condensation.
3) Check daily for overheating of the motors.

Float Controls

1) Inspect the float control daily.
2) Replace if the float or float rod is badly

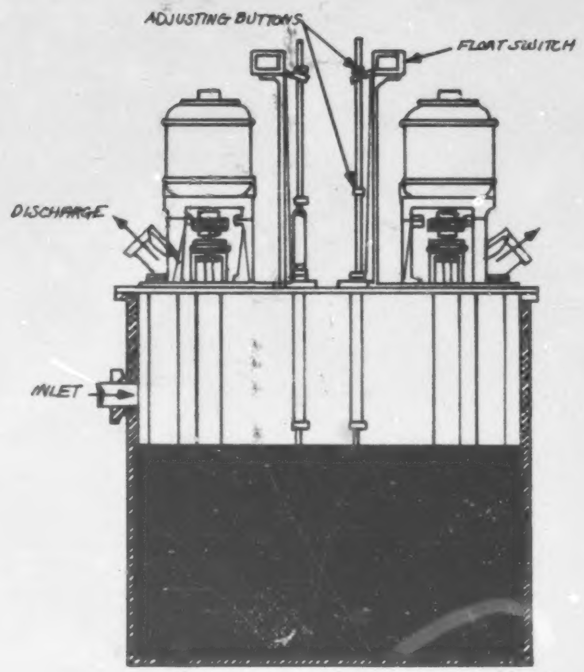


FIGURE 42—Pump chamber with alternating pumps.

corroded.

3) If switch is out of adjustment, a skilled workman may be needed to make repairs.

Cleaning

1) Clean the screen if clogged with grease and suspended matter.
2) Clean the chamber as required.

SURFACE SAND FILTERS

Surface sand filters have a sand and gravel bed without a cover over it. (Figure 43) The bed is flooded by discharges from a pump or dosing chamber. This process removes solid matter and oxidizes the sewage.

Check Daily

Surface sand filters should be checked every day for clogging, which is indicated when sewage remains on the surface of the sand longer than 30 minutes. Clogging is caused by solids and grease from the septic tank. Observe the sewage in the influent chamber. Liquid should be fairly clear and free from visible solid matter.

Debris

Clogging may be caused by weeds, leaves, and other surface debris. If necessary, build a fence around filters to prevent trespassing and dumping of rubbish. Pave the slopes of surrounding banks or build a tight wall to keep soil and other surface wash off the beds. Pull out weeds and roots.

Sewage Distribution

Large volumes of sewage must be dosed into the filter beds. Don't allow sewage to trickle into the bed continuously. Keep the sand raked level and adjust the inlet for even distribution. Distribution troughs, tile, or pipe are needed for even distribution.

Overloading

Clogging may be caused by applying too much sewage to the filters. Loading rates and estimated flows may be verified by contacting the State of Illinois Sanitary Water Board, Department of Public Health.

The wrong kind of sand also will clog filters. Use only state department of health approved sand.

Remedies for Ponding

If sewage is not absorbed, divert the flow to the second filter. Allow the sand to dry thoroughly. Scrape the thin crust off the surface after filter bed has dried. Do not use rake or rotary tiller before all foreign material is removed. If sewage still ponds, take the filter bed out of service again and allow sand to dry completely. Remove an inch or two of incrusted sand with a flat shovel. This should be done about once per year. When sand has been reduced by about four inches, add clean, approved

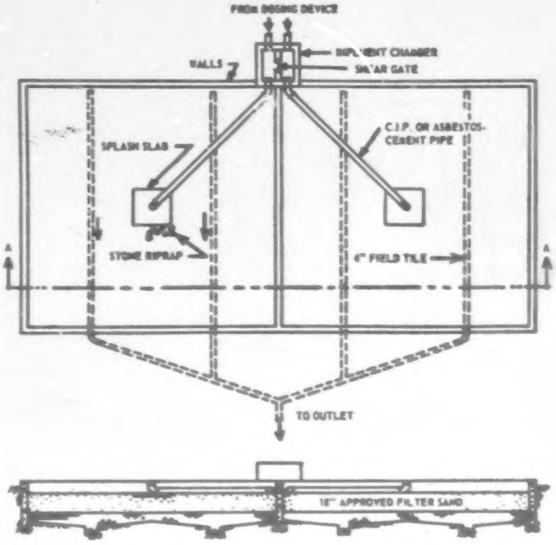


FIGURE 43—Surface sand filter dosed by flooding.

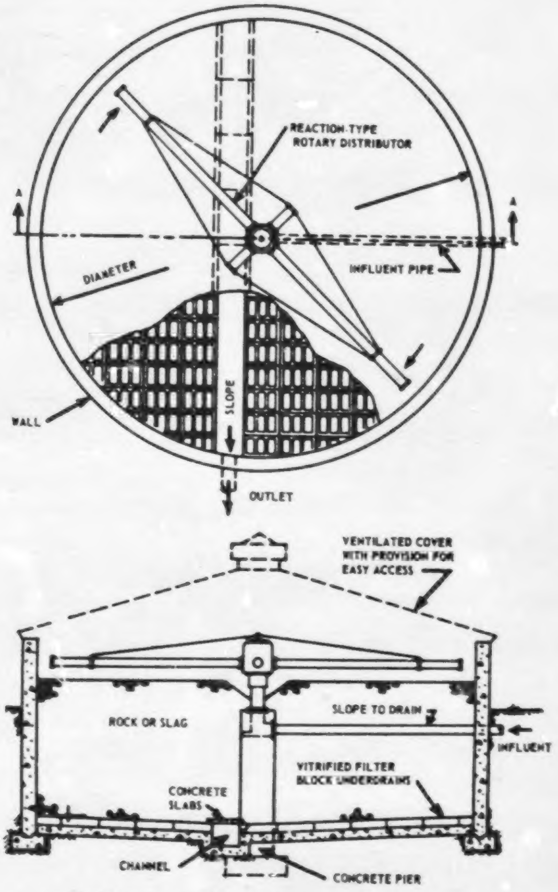

REACTION-TYPE ROTARY DISTRIBUTOR
A
A
INFLUENT PIPE
DIAMETER
SLOPE
WALL
OUTLET
VENTILATED COVER WITH PROVISION FOR EASY ACCESS
SLOPE TO DRAIN
ROCK OR SLAG
INFLUENT
VITRIFIED FILTER BLOCK UNDERDRAINS
CONCRETE SLABS
CHANNEL
CONCRETE PIER

FIGURE 44—Trickling filter.

filter sand to original depth. The state department of health will furnish specifications for the sand and test it for suitability.

TRICKLING FILTERS

A septic tank is necessary ahead of the trickling filter in order to prevent clogging of filter nozzles. A trickling filter is a bed of stone or slag over which sewage is distributed by rotating arms or fixed spray nozzles. (Figure 44) Sewage trickles through the stone or slag and is collected in the under-drainage system. The under-drainage system also provides ventilation.

Ordinarily a trickling filter will slough; that is, the sewage solids will break away in the spring and fall of each year. These solids must be removed from the final settling tank daily, either by pumping them to the first settling tank or by pumping them to a sludge lagoon.

Rotary Distributors

Rotary distributors are used on some surface sand or trickling filters. (Figure 45) The sewage is evenly distributed over the filter through holes or nozzles in the arms.

Trickling filters must be inspected regularly for ponding.

Causes of Ponding

1) Sewage on the filter must contain dissolved oxygen to encourage growth of bacteria. Overloading sometimes destroys oxygen, causing ponding and odors.
2) An accumulation of leaves on the filter.
3) Unsatisfactory stone or slag.
4) Excessive amounts of grease and solid matter from the septic tank.
5) Improper care of septic tank. Clean it regularly.

Remedies for Ponding

1) Rake or fork the surface.
2) Punch holes in the top layer.
3) Rest the filter several days.

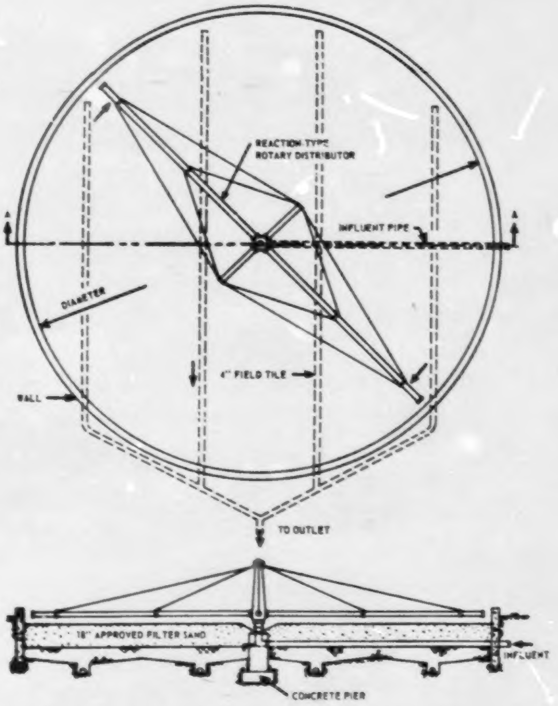

REACTION-TYPE ROTARY DISTRIBUTOR
A
A
INFLUENT PIPE
DIAMETER
4" FIELD TILE
WALL
TO OUTLET
18" APPROVED FILTER SAND
INFLUENT
CONCRETE PIER

FIGURE 45—Rotary distributor.

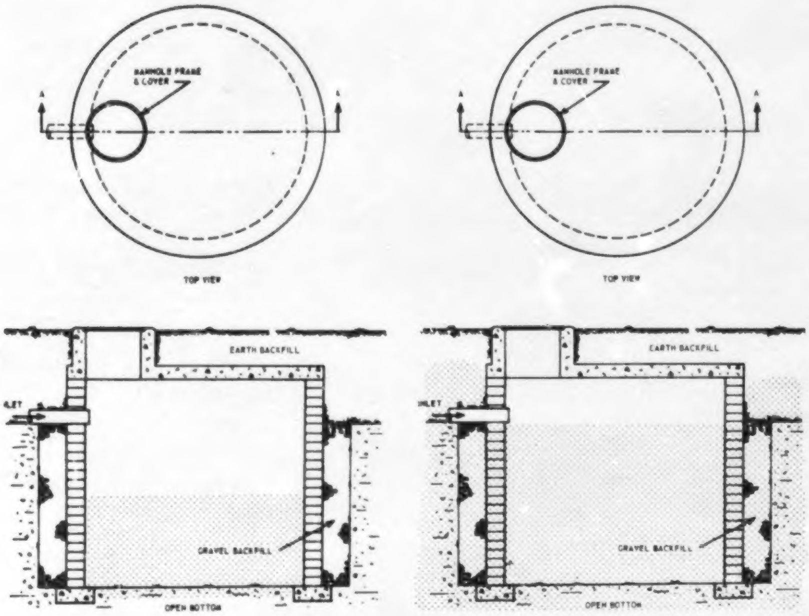


FIGURE 46—Leaching well (left) and saturated leaching well (right).

4) Flush the surface with a high pressure stream of water.
5) Replace small size stones with approved stone or slag.

Maintenance

1) Check the turntable for binding.
2) Follow manufacturer's recommendations for lubrication and for cleaning the media.
3) Inspect and clean nozzles daily. If holes are clogged, distribution of sewage will be uneven and result in clogging stone and sand filters. It may lead to the breeding of insects in trickling filters.
4) Open the covers at the ends of the arms and flush the arms daily while the equipment is operating.
5) Keep the septic tank in good condition. Clean it regularly.

LEACHING WELL

A leaching well is a hole in the ground, walled with brick, concrete block, or stone. (Figure 46) It allows liquid from the septic tank to seep into the subsoil.

Clogging of the leaching well may be caused by solids and grease from the septic tank. Proper septic tank care is extremely vital, therefore. Clean it regularly. When the subsoil becomes so saturated with sewage that leaching will no longer take place, it is necessary to build a new one.

Extended Aeration

Sewage can be oxidized to a flaky ash of very little bulk by bubbling sufficient air through it for a sufficiently long period of time. This process has been called "Extended Aeration" because of the greatly increased amount of air used.

The sewage passes through a bar screen to remove very large solids and debris. It then flows directly into the aeration tank which is the heart of the system.

The aeration tank is rectangular with means to bubble air in near the bottom at one end through a suitable diffuser which breaks up the air into small bubbles. The air is forced in by an air blower.

Each blower is sized to treat the full sewage load. The second blower serves as a standby unit.

A variety of treatment activities take place at the same time and in the same tank. The turbulence produced by the air, in addition to mixing the fresh sewage with the activated sludge in the aeration tank, tends to break up the sewage solids. It also causes the contents of the tank to be turned over and over, bringing the contents in contact with the outside air surface where additional oxygen may be picked up. Aerobic bacteria and other living organisms present in the sewage are stimulated to activity by the abundant oxygen and proceed to digest the organic sewage solids present both in suspension and in solution.

After aeration, the sewage flows to a settling basin. The solids are returned from the bottom of the settling basin to the aeration tank for further treatment and to seed the incoming sewage with living organisms.

A sludge storage tank is provided to receive excess sludge if any forms.

Sewage treatment plants of this design may generally be broken down into the following steps: (1) screening, (2) aeration, (3) settling, (4) sludge holding, (5) chlorination. These five steps are normally arranged as follows:

1) **Bar Screen.** A bar screen is placed at the aeration tank inlet to intercept solids larger than that which will pass a one-inch opening.

2) **Aeration Compartment.** This section of the plant is where the actual aeration takes place. It consists of a tank sized for 24-hour retention, a series of pipes and diffusers to disperse the air, and a blower to deliver the air. There are two connected aeration compartments. Air volume is controlled by aluminum valves. In the two aeration compartments, air diffusion units spaced at equal intervals along the side of the compartments produce a uniform roll of the mixed liquor over the entire length of these compartments.

3) **Settling.** This section of the plant is designed to settle out solids. It consists of a tank with hoppers, baffles, and an effluent weir. It is sized for four-hour retention. In this tank there are sludge return airlifts to return sludge to the aeration tank, an automatic airlift skimmer, and a form of froth control. Aerated liquor enters the final tank through two rectangular openings in the partition wall above the bottom of the hoppers. Two six-inch adjustable weirs reach across the entire width of the tank and collect the effluent at a rate that will maintain the best settling characteristics.

4) **Sludge Holding Tank.** Opposite the final settling tank there is a sludge holding tank with a surface opening for cleaning. Two airlift pumps deliver sludge from the hoppers at the final tank to either the inlet end of the first aeration compartment or the sludge storage tank.

5) **Chlorination.** This section of the plant is designed to chlorinate the plant effluent. It consists of a chlorine solution feed pump, a chlorine solution tank, and a chlorine contact or mixing tank. Chlorination equipment is housed in a precast concrete unit with removable cover.

RECOMMENDED MAINTENANCE

1) Be sure tanks are kept completely free of mud, sand, gravel, rocks, boards, etc.
2) Check oil level in the blower before starting up.
3) Do not turn on spray pump until the plant is completely filled and water running out of discharge. (If spray pump is provided.) Scum return pipe should be adjusted so that water will be about ⅜″ to ½″ deep in the notch. Adjust air valve so that water falls about 2″ down in the pipe.

Daily

1) Make a daily inspection of the plant.
2) Rake the bar screen and burn or bury screenings.
3) Look for a uniform discharge of air in aeration tanks. (A quiet area indicates a clogged nozzle. Close air valve, lift diffusion unit, and clean nozzle.)
4) Hose down the plant to remove foam and untidiness.
5) Squeegee growth from tank walls.
6) Check and break up scum, if any, in settling tank, to insure proper return through the skimmer.
7) Keep the chlorine stock solution tank filled when needed.
8) Observe final effluent for clarity.
9) All areas having foam build-up should be washed down with water spray.

Weekly

1) Alternate blowers.
2) Clean air filter.
3) Check blower belts – center vertical movement ½″ to 1″.
4) Check time setting on time clocks.
5) Scrape wall and hoppers of settling tank.
6) Clean trash and weeds from around plant and equipment.

Monthly

1) Open gear box, oil drip drain – add oil if no drip.
2) Lubricate blower bearings.
3) Check air filter and clean when necessary.

Semi-Annually

1) Change oil in gear box.
2) Lubricate blower motors.

Annually

Wire-brush and paint all rusted metal.

Lubrication

Blower. Before starting blower, be sure to check to see if oil has been put in the gear housing.

Blower bearings. Renew grease as needed with best grade, high temperature ball bearing grease (not ordinary cup grease) about once a month.

Common Problems

1) Motors will not run:
   - General power outage.
   - Fuses blown — replace; reset circuit breaker.
   - Motors overloaded – push reset button; check overload heaters if reset does not start motor.
2) Excessive foaming or liquid appears soapy in aeration compartment:
   - Over aeration – reduce running time.
   - Lack of solids (usually found only during the first few weeks of operation).
   - Excessive use of detergents – eliminate them before they enter the plant.
   - Spray with water hose to break up foam.
3) Liquid is black, caused by large amount of septic sewage or blower is not running long enough:
   - Aerate until chocolate brown color returns.
   - Find source of septic sewage and eliminate.
   - Set time clock for adequate aeration time.
   - Check V-belt drive.

It is important to check the appearance of the aeration tank contents. A satisfactorily operating plant will have a heavy concentration of chocolate brown sludge with little or no foam in the aeration compartment. This sludge should settle readily so that the water in the upper part of the final settling compartment will be clear and free of solids, not cloudy or turbid. Should the aeration compartment contents not have a brown color, but be dark gray or black, and should they not be free of objectionable odor but have a septic sewage odor, an inadequate air supply would be the cause. With experience, the need for additional air can be accurately gauged by the appearance of the aeration tank liquid.

4) Sludge accumulation on top of settling tank:
   - Airlift skimmer not returning.
   - Sludge return airlifts not returning, or not returning enough. Check hoppers for sludge build up.
   - Excessive amount of grease (check grease trap and clean, if necessary); or, eliminate before entering plant.
   - Refer to special section on "Sludge Problems."
5) Large quantities of solids going over effluent weir:
   - Sludge airlifts not returning, or not returning enough. Check air lines and airlift tube for blockage.
   - Plant overloaded – check sewage flow and volume and have raw sewage analyzed for B.O.D. and suspended solids.
6) Heavy black sludge on bottom of settling tank:
   - Scrape more often.
   - Return more sludge by opening needle valve to increase flow to airlift.
7) Large amount of scum on surface (may be due to clog in air line):
   - If clogged, rod out line or blow out by shutting off discharge end and opening needle valve.
   - Spray surface with water to break up foam and release gas formed bubbles.

SLUDGE PROBLEMS

During the first few weeks of a plant's operation, one of the most common problems is the accumulation of sludge on the hopper slopes of the settling tank. This problem may be almost completely eliminated by proper care and maintenance.

The purpose of the tank is to settle out and separate the solids that pass through from the aeration tank. Normally the liquid in the settling tank should be still to accomplish this purpose. However, one of the characteristics of sludge is that it is likely to be stringy and sticky during the early weeks of plant operation. As it settles toward the bottom of the tank, the hopper slopes are the most convenient place for the stringy, sticky masses of sludge to stop settling and come to rest.

After a week or so the continuous build up of sludge will finally become a spongy mass completely filling the lower half of the tank. This will stop the normal movement of sludge to the hopper bottom where it is picked up by a sludge return pipe that returns it to the aeration tank for retreatment. After a short time this spongy mass will form a gas and break up the mass into chunks of sludge that float to the surface of the water. Here, if the condition persists, it will finally become a solid mass again growing deeper as the sludge builds up from the bottom. Naturally this solid sludge condition prevents the equipment in the settling tank from performing properly. The skimmer, the froth control pump, and the final discharge weir are all hampered in their operation. In addition, the sludge mass gives off a very strong stench which makes for almost unbearable conditions to surrounding areas.

Proper preventive maintenance is the best cure for sludge accumulation.

Every day during the first few weeks of operation the operator or some responsible person should visit the plant to see that all equipment is running and to check the settling tank.

A small scraper is used to keep the hopper slopes free from sludge build up. The hopper slopes begin about three to five feet below the water level. The operator should scrape all around the hopper with a slow, easy, downward motion, just enough to help move the sludge toward the bottom of the hopper where it can be picked up by the sludge pump. Do not stir or agitate sludge roughly or it will break up and rise to water level. If this happens, the chunks must be dipped back into the aeration tank for further treatment.

The above outlined procedure should be followed faithfully until the plant bacteria begin to properly "work." This is usually from three to five weeks, dependent on the strength of the raw sewage coming into the plant. In almost every case, the above procedure will prevent sludge problems.

After the plant begins to "work," this procedure may be reduced to weekly or even monthly as the operator may determine from experience. The amount of sludge being returned to the aeration tank may be seen by watching the discharge pipe or pipes that empty into the aeration chamber.

In addition to sludge build-up, there are other associated conditions which need attention. It is possible for a sludge return pipe to be discharging clear water while there are three or four feet of sludge in the hopper. This occurs when soft sludge packs solid almost to the hopper bottom except for a narrow air channel running down through the mass to the pump intake. Clear surface water is pulled down through this channel and up through the pump without disturbing the sludge mass. Therefore, visual checking of the sludge return discharge is not sufficient. It is necessary to gently move the mass downward to the pump intake.

Another common condition is a plugged sludge airlift. Sludge, being heavier than water, will normally settle to the hopper bottom. If the sludge pump is not returning at least "one third of a pipe full" into the aeration tank, the slower movement of sludge will tend to allow the sludge to pack in the one-foot-square area at the hopper bottom and pump intake. Finally the sludge begins to build up inside the airlift tube until it is blocked completely. This may be remedied by shutting off air supply to all other equipment and opening air control valve to the blocked sludge pump wide open. If blockage isn't moved, the three-inch valve should be turned off, causing the air to reverse its direction and back flush the pump. In the absence of a valve, the pipe plug must be removed and the discharge pipe closed off at the tee with a shop rag or plumber's stopper to divert the air downward through the vertical pump tube. The great volume of air should break up the solid mass at the pump intake. The chunks that rise to the top must be dipped back into the aeration tank or broken up into small pieces to be returned by the skimmer.

When mud gets into a plant the part that gets into the settling tank will naturally sink to the hopper bottoms. Here it mixes with the sludge and forms a heavier, more solid mass than sludge alone. The sludge return airlifts will not lift heavy mud. Mud should be removed as soon as it is discovered.

Remember: A clean, properly cared for plant means less repairs and maintenance and more efficient operation.

ENVIRONMENTAL PROTECTION

The Environmental Protection Act requires that each treatment plant must have at least one operator who has direct charge of the operation and makes regular inspection of the plant. This person must have a Certificate of Competency.

The EPA also requires regular submissions of operation reports. Application forms, operation report blanks and explanatory sheets may be obtained from the following location:

Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

Electrical Systems

LIGHTING AND LAMPS

Several types of lighting sources are used in school buildings today, in combination with appropriately designed fixtures. These are the fluorescent lamp (hot and cold cathode), incandescent filament lamp, and the mercury vapor lamp (for outdoor lighting).

The fluorescent lamp is becoming the principal light source for schools because it produces three times the light and has nine times the life of the same wattage incandescent lamp. Sodium vapor and mercury vapor lamps have grown increasingly popular for low ceiling applications.

There are eight shades of "white" lamps, but the two most widely used are the "Cool White" and the "Deluxe Cool White." The latter has more red in its spectrum and is more flattering to people and furnishings. When replacing lamps, match those being removed as to type of starting device and ballast, lamp terminals, and color shade.

If a lamp fails to light, the cause may be:

1) **Poor lampholder contact.** Twist gently in the socket. If the lamp flashes, look for a loose lead wire or lampholder part.

2) **Replace** the starter if the lamp is a preheat type.

3) **Burned out lamp.** Check the date installed to see if the lamp has burned its rated life (mark date on all lamps when replacing them). If the lamp has had a short life, check ballast, starter, and lamp purchase source.

4) **Faulty fixture.** Try the lamp in an operating fixture. If it is okay, check the original fixture for dirt, dust, and moisture accumulation. Also, look for worn lamp holder contacts or defective ballast. (Some ballasts have external fuses; check for blown fuses.)

Cleaning Compounds for Light Fixtures

Here are some guidelines for cleaning and protecting the various surfaces found on fluorescent light fixtures:

- **Aluminum** — Use mild soap and cleaners and thoroughly rinse with clean water immediately after cleaning. Do not use strong alkaline cleaners.
- **Porcelain Enamel** — Use non-abrasive cleaners. Detergents and most automobile and glass cleaners are satisfactory.
- **Synthetic Enamel** — Use mild cleaners. Do not allow the fixture to soak in solutions as it may soften. Do not use alcohol or abrasive cleaners. Detergents are satisfactory.
- Glass — Same as Porcelain Enamel. Use dry cleaners on clear glass panels but not on etched or sand blasted surfaces. Detergents are satisfactory.
- **Plastics** — Dust is attracted by a static charge developing on plastic. Cleaning twice a year in a detergent will provide satisfactory relief from static dirt accumulations. Destaticizers are available which give a greater protection if desired. *Do not wipe plastic dry.* After rinsing allow to air dry.

5) **If the lamp blinks** or flashes it may indicate the end of lamp life, as indicated by darkened ends and reddish glow.

6) **Lamps which** are lit but have long horizontal dark streaks are usually in a cold air path, such as from an air conditioning system. Deflect air away from lamp and the condition will disappear.

Unless fixtures and lamps are properly maintained and kept clean, 50 percent of the illumintion produced and 50 percent of the electricity going through the meter may be wasted.

Proper maintenance of a lighting system includes cleaning and washing fixtures and lamps as well as surrounding walls and ceilings. It also includes repair or replacement of defective components of the lighting system. With the high cost of labor, it is more economical to replace a component or a complete unit than to spend the time to repair a device that fails.

It is important to keep an adequate stock of replacement parts, including lamps, starters, ballasts, sockets, and fixtures to match those in service.

With the trend to more complex lighting systems, the time and labor to clean these systems have increased. Fluorescent installations have more fixture area and lamp surface than their incandescent counterparts. The following steps are suggested for cleaning fluorescent fixtures:

1) **Clean louvers** with two people. The person on the floor receives louvers and cleans them with sponge and detergent. A person on the ladder cleans fixture surfaces. Plastic louvers should be washed, rinsed, and drip dried. Do not wipe dry, as an electro-static charge will form and speed dirt accumulation.

2) **Clean lamps at floor level.** Use a wash sponge and a separate rinse sponge. Make a downward stroke with the wash sponge in one hand followed by the rinse sponge in the other.

3) **Make fixtures shock-free.** Either turn off the circuit or use insulating tape to cover the sockets. Dummy lamp bases can also be inserted in the sockets.

4) **Brush heavy dirt** deposits off the top of the fixture and then wash with detergent.

5) **Use a paint brush** and detergent around sockets. Use second brush and rinse water and allow to air dry. Use a wash and rinse sponge for the remainder of the reflector.

CIRCUIT BREAKERS

Most school electrical systems are protected by circuit breakers — either molded-case breakers or air-circuit breakers.

Circuit breakers in lighting panelboards usually are of the plug-in, molded-case, thermal-magnetic type. They compensate for ambient temperatures and will carry full NEC loading (80 percent of rating) in room temperatures as high as 120° F.

When a short-circuit or overload trips a breaker, the operating handle assumes a position midway between "OFF" and "ON," identifying the circuit in trouble. When this occurs, check the circuit for the cause of the fault; then switch the handle to "ON" to restore the service.

The maintenance of panelboards is quite simple. Check all connections once a year for tightness. Keep the interior of the enclosure dry and free of dust. If a unit fails, replace it; the cost is nominal. If breakers open for no apparent reason, check each circuit which terminates in the panel with a tong ammeter to be sure the load it is carrying does not exceed NEC ratings.

NOTE: The performance testing of circuit breakers is not a normal maintenance function and should be performed only by qualified, properly equipped personnel.

MOLDED-CASE BREAKERS

Molded-case breakers are sealed, reasonably tamper-proof units. In ratings up to 100 amperes, these units are considered in terms of replacement rather than maintenance. Unless factory seals are broken, no extensive maintenance is possible. Breaking of the seal terminates the factory warranty and, in many types of breakers, voids the label of Underwriters Laboratories.

A qualified electrician should electrically test all such breakers under load for calibration and positive operation *at least once a year.* Unless a breaker is operated occasionally, manually and electrically, it can become inoperable through disuse. If not electrically operated for extended periods, the internal mechanisms and linkage may become stiff and prevent the breaker from tripping even if three or four times the rated current is applied. Once operated, however, the breaker in most instances will be found to be serviceable.

Electrical testing under load will quickly indicate whether both the magnetic and thermal trip elements are functioning properly.

AIR-CIRCUIT BREAKERS

Checks twice yearly of this heavier switchgear is recommended. A special check should be made after each interruption of a heavy short-circuit current. If a breaker is kept in either an open or closed position for long periods, it should be opened and closed several times at periodic intervals to insure continuing and proper operation.

CAUTION — Before inspecting or adjusting any breaker, make sure that all service to the breaker is dead and that the breaker is completely disconnected from any bus or line. Check the grounding connection on the frame to be sure it is intact. Finally, temporarily ground all breaker studs and current-carrying parts during the inspection.

Annual Inspection

1) **Check contacts** for cleanliness. Check arcing contacts and if pitted or burned, dress or replace. Do not attempt to repair laminated contacts that are badly burned or pitted; replace them.

2) **Check terminal connectors** for overheating. Make sure they are mechanically tight.

3) **On mechanisms,** check all nuts and bolts to be sure that they are in place and tight and that no pins or cotter pins have fallen out. Check all moving parts for binding. Operate breaker several times for functioning of all parts. Lubricate bearing points lightly.

4) **Check to be sure** that all parts of the tripping device and trip latch move freely and that the armature of the overcurrent trip device has sufficient travel to release the breaker latch.

5) **Check the load** current against the breaker rating.

6) **Check the control** switch and the closing relay for proper operation. Replace any burned-out indicating lamps.

7) **Check the mechanical** condition of the enclosure. Make sure the operating handle is not blocked in any way. Make sure the ground connection of the enclosure is mechanically intact.

8) **Check the positive** tripping of undervoltage devices. If equipped with a dashpot, make sure the dashpot is clean.

FIRE ALARM SYSTEMS

A fire alarm system must be both electrically and mechanically secure. This means that all devices, as well as the operating power, must be supervised. The fire alarm system should be tested at least monthly by:

- Disconnecting a signal
- Disconnecting a station
- Disconnecting a detector
- Disconnecting the operating power

When any of these is done, the trouble bell *must* ring.

Signals can be tested by operating a test button or activating a station.

Heat detectors can be tested by putting a warm damp cloth around the detector for about one minute. *Rate of rise detectors* will actuate if the temperature is raised 15° F. in one minute. *Fixed temperature detectors* will operate only at the rated temperature; when the temperature reaches this point the solder melts and closes the electrical contacts. Hence, any test will destroy the detector.

Do not test a detector with a lighted match or other open flames, because this will melt the solder.

On the so-called smoke detectors, the method of testing and maintenance is different. These usually are made so that the dirtier they get the faster they will fire or activate. This means that their screens must be cleaned at regular intervals, depending on the location — usually once or twice a year. Detectors of the radio-active type must be given a wipe test every three years after the date of installation.

On stations of the coded type, which send out several rounds of code, there is a test key that provides for a "silent test." By inserting the key and operating the station, the movement goes through its rounds without sending an alarm. On stations of this type, there is a key for making single-tap tests on the system. Operation of the key causes the alarm bells to tap one stroke, indicating the alarm system is intact.

On fire alarm systems of the annunciated type there should be a means of testing the lamps. On most annunciators there is a test button which lights all the lamps once, revealing any defective or burned out lamp.

Systems which are connected to municipal fire alarm systems should be disconnected during local tests, so that alarms do not go into the municipal system. However, with the assistance of the fire department, the municipal system should be checked regularly for reliability.

MOTOR STARTERS

Warning — Turn off power ahead of the starter before performing any of the following operations. Check incoming line terminals with a voltmeter to ascertain positively that the equipment is totally de-energized. Also, note that many magnetic starters have control voltages derived from sources separate from starter terminal voltages. It is imperative that *both* power sources be de-energized prior to inspection of starter.

Inspect starters once each year or after any severe electrical fault. Look for any moisture or signs of previous wetness or dripping inside the starter. Condensation in conduits or dripping from outside sources is a common cause of starter failure.

If there is an appreciable accumulation of dust and dirt, clean out the starter by using a brush, vacuum cleaner, or clean lint-free rags. In order to avoid blowing dust into other equipment, do not use a blower or compressed air.

Carefully inspect all visible electrical joints and terminals in the electrical wiring systems. Retighten them if there is any sign of overheating or looseness. If joints or terminations appear to be badly discolored, corroded or pitted, or show signs of having been subjected to high temperatures, the parts should be disassembled and replaced or cleaned.

Examine fuse clips in combination starters. If there is any sign of overheating or looseness, check the spring pressure and tightness of the clamps. Replace the fuse clips if the spring pressure compares unfavorably with that of other identical fuse clips. Be sure that the condition which caused the overheating has been corrected.

Check all devices for missing or broken parts, proper spring tension, free movement, rusting or corrosion, dirt, and excessive wear.

Clean off oil and sooty deposits. Replace contacts if appreciable material has burned away or if material is charred or pitted. (Contact erosion is the most common cause of stater failure.) When replacing contacts, also replace contact pressure springs.

Check thermal overloads and fuses (in combination starters) to make sure they have the proper ampere rating and interrupting rating. Never attempt to defeat the rejection mechanism which prevents the installation of the wrong type of fuse.

The table on pages 104 and 105 lists troubles encountered with motor controls, their causes and remedies.

Magnetic Contactors and Starters

Trouble	**Cause**	**Remedy**
CONTACTS		
Contact chatter	1) Broken shading coil.	1) Replace magnet and armature.
	2) Poor contact in control circuit.	2) Replace the contact device or use holding circuit interlock (3 wire control).
	3) Low voltage.	3) Correct voltage condition. Check momentary voltage dip during starting.
Welding or freezing	1) Abnormal inrush of current.	1) Check for grounds, shorts or excessive motor load current or use larger contactor.
	2) Rapid jogging.	2) Install larger device rated for jogging service.
	3) Insufficient tip pressure.	3) Replace contacts and springs, check contact carrier for deformation or damage.
	4) Low voltage preventing magnet from sealing.	4) Current voltage condition. Check momentary voltage dip during starting.
	5) Foreign matter preventing contacts from closing.	5) Clean contacts with freon. Contactors, starters, and control accessories used with very small current or low voltage should be cleaned with freon.
	6) Short circuit.	6) Remove short or fault and check to be sure fuse or breaker size is correct.
Short contact tip life or overheating of contact tips	1) Filing or dressing.	1) Do not file silver tips. Rough spots or discoloration will not harm tips or impair their efficiency.
	2) Interrupting excessively high currents.	2) Install larger device or check for grounds, shorts, or excessive motor current draw.
	3) Excessive jogging.	3) Install larger device rated for jogging.
	4) Weak tip pressure.	4) Replace contacts and springs, check contact carrier for deformation or damage.
	5) Dirt or foreign matter on contact surface.	5) Clean contacts with freon.
	6) Short circuits.	6) Remove short or fault and check to be sure fuse or breaker size is correct.
	7) Loose connection.	7) Clean and tighten.
	8) Sustained overload.	8) Check for excessive motor load current or install larger device.

Trouble	**Cause**	**Remedy**
COILS		
Open circuit	1) Mechanical damage.	1) Handle and store coils carefully.
Roasted coil	1) Over voltage or high ambient temperature.	1) Check application, circuit and current. Replace coil.
	2) Incorrect coil.	2) Install correct coil.
	3) Shorted turns caused by mechanical damage or corrosion.	3) Replace coil.
	4) Under voltage, failure of magnet to seal in.	4) Correct system voltage.
	5) Dirt or rust on pole faces increasing air gap.	5) Clean pole faces.
OVERLOAD RELAYS		
Tripping	1) Sustained overload.	1) Check for grounds, shorts, or excessive motor currents and correct cause.
	2) Loose connection on load wires.	2) Clean and tighten.
	3) Incorrect heater.	3) Heater should be replaced with correct size.
MAGNETIC AND MECHANICAL PARTS		
Noisy magnetic	1) Broken shading coil.	1) Replace magnet and armature.
	2) Magnet faces not mating.	2) Replace magnet and armature.
	3) Dirt or rust on magnet faces.	3) Clean. Replace if rust is excessive.
	4) Low voltage.	4) Check system voltage and voltage dips during starting.
Failure to pick-up and seal	1) Low voltage.	1) Check system voltage and voltage dips during starting.
	2) Coil open or shorted.	2) Replace
	3) Wrong coil.	3) Replace
	4) Mechanical obstruction.	4) With power off check for free movement of contact and armature assembly.
Failure to drop-out	1) Gummy substance on pole faces.	1) Clean pole faces.
	2) Control circuit continues to be energized.	2) Check coil circuit.
	3) Worn or rusted parts causing binding.	3) Replace parts.
	4) Residual magnetism due to lack of air gap in magnet path.	4) Replace magnet and armature.

Food Service Equipment

KITCHEN MACHINERY

All kitchen machinery food contact surfaces must be washed and sanitized at the end of each day's use. If the surface is small enough to be placed into the dishwashers, it will be sanitized assuming the dishwashing machine is working properly. Otherwise, the food contact surface, after it is cleaned, must be rinsed with a 100 parts per million chlorine rinse solution. All food service equipment must be lubricated with food safe lubricants.

DISHWASHERS

Complete the following procedures daily.

1) Before each use:
   - Check temperature of all thermometers. If they are under or over the proper temperature, adjust or repair *before* the dishwasher is placed in service. The temperatures must be at the proper level; if not, an emergency exists and all eating utensils must be sanitized with a 100 parts per million chlorine rinse or single service utensils used.
   - Check pressure gauge. The pressure on the rinse line must never be above 20 p.s.i.
2) Turn off booster heater.
3) Open all doors of machine and remove all manifold end cap assemblies.
4) Check all manifold nozzles for obstruction and clean as necessary.
5) Close door and flush machine by briefly operating the dishwasher.
6) Open all drains.
7) Clean off soiled and clean dish tables and rinse into dishwasher.
8) Remove and clean all strainer pans.
9) Remove curtains and wash out interior of the machine; open all doors and allow machine to dry.

Most electric motors have grease plugs. Remove plugs and lubricate about twice a year. Do not over lubricate. Pumps do not need lubrication.

Replenish lubricant in speed reducer as needed. Check monthly. Every six months remove plugs and drain the lubricant. Replace plugs and refill with new lubricant. Be sure that the vent hole in the plug is kept open.

Clean and wash arms and check for obstructions in nozzles daily.

DISPOSERS

Run disposers for five to ten minutes after daily use in order to clear all waste lines properly. If possible, use hot water.

Annually, check cutting teeth, cutting ring, cutting bowl, and cutting bars for wear. Replace as necessary.

Motors are permanently grease packed and do not require lubrication.

PEELERS

Ball bearings and motors are generally sealed and require no lubrication.

Replace peeling disc when needed. It should last several years.

Check door gasket monthly for leaks. Replace if needed.

Annually have a local service agency inspect and check the operation of this unit.

Run peelers five to ten minutes after daily use.

MIXERS

General: All exterior surfaces should be wiped clean with a hot damp cloth daily. A mild soap solution may be used.

Apply a small amount of mineral oil to the bowl slideways monthly.

Mixing bowls should be scrubbed with hot water and a soft bristle brush after mixing has been completed. Wash all agitators and mixer shafts in hot water. Flush mixer bowls with hot water immediately after mixing products which contain sugar to prevent metal discoloration and pitting of tinned surfaces.

5, 10, 20 and 30-quart series: These units will have their motor grease packed so they will require very little attention. The transmission gearing is packed with grease which will last several years.

Lubricate the bowl lift with one or two drops of oil monthly. Remove the drip cup monthly and wipe it clean.

60 and 80-quart series: Wash all agitators and mixer shafts in hot water, then if possible, place them in the dishwasher for sanitization. Otherwise, wipe all food contact surfaces with a 100 parts per million chlorine rinse.

The agitator shaft bearings are sealed and do not usually require attention. If greasing becomes necessary the local service agency should do it.

The lift screw, gearing mechanism and slideways should be greased annually. The drip cup should be removed and cleaned monthly.

The rear bearing is grease packed and should require no attention. If greasing does become necessary, the local service agency should perform this procedure. Check the oil level in the transmission and in the planetary gear weekly.

Have a local service agency inspect and check the operation of these units annually.

When the mixer bowl surface is worn or pitted, have the bowl retinned.

SLICERS

Motors and bearings are grease packed and require no attention.

Semi-annually, oil should be added to the carriage slides, rod wicking pads and slice thickness gauge.

Sharpen knife as required. Keep honing stone free from grease by washing periodically.

Have a local service agency inspect and check the operation of these units annually.

FOOD CHOPPERS

Motors and bearings are grease packed and require no attention. Operate the unit only with food in the bowl to avoid damage to the running knife and plate.

Inspect drain hole periodically to make sure it is clear. If clogged, open with a pin or paper clip.

FOOD CUTTERS

The machine has sufficient lubrication when it leaves the factory. Check lubricants before placing the machine in operation.

The knife assembly should be removed as a unit for cleaning. Check knife clearance monthly and make necessary adjustments. Refer to the manufacturers instruction book for the proper method.

Check lubricant in the bowl drive gear case and the attachment drive gear case each month.

Annually, have this unit inspected by the local service agency. Clean this unit daily with a damp cloth and a mild detergent.

BOOSTER HEATERS

Weekly, turn off electric power to booster heater and drain unit to remove scale in the bottom of the tank. Refill with water before restoring power.

SELF-LEVELING DISPENSERS

General: Before cleaning units, remove all contents. Disconnect electrical power to all heated models and allow to cool.

Drop-in units: Lubrication of this mechanism is not necessary. Remove unheated models from the counter, wash with warm soapy water, flush out through drain holes, dry and replace. Do not immerse heated models in water.

Mobile units: Lubricate link-chain and sprocket or lowerator type mechanism on all models every six months with light machine oil on a clean cloth. Lubricate caster swivels once a year with light machine oil.

Vacuum out spring chamber or brush dirt, dust, etc., out through clean-out slot at base of unit.

CARTS AND RACKS

Lubricate caster swivels once a year with light machine oil. Clean all carts and racks daily with hot water and mild soap.

COOKING EQUIPMENT

The service connections on all gas fired, movable cooking equipment must be checked for leaks regularly, especially when the units are moved for cleaning or maintenance.

RANGES

General: All ranges should be given a general check up annually. The exterior should be washed daily with a mild soap and water and dried with a clean cloth.

Be sure doors close snug and tight. Carefully clean all crumbs and encrusted matter from around oven door openings so door will seal properly. To be sure that all doors will continue to seal properly, do not slam or stand on doors.

If correct by-pass flame on gas ranges cannot be obtained, dirt is probably holding the main control valve partially open. To clean, turn off main gas cock, unscrew cap assembly, and carefully wipe disc and seat in valve. Replace cap assembly and tighten securely.

Open Tops: After top grids are entirely cooled, soak in water and a good grease solvent, first removing foreign particles by brushing with a stiff brush. This procedure should be completed daily or as necessary.

Hot Tops: After top plates have cooled somewhat, rub vigorously with heavy burlap or steel wool. Remove any grease or dirt lodged under flanges, lids or plates. This procedure should be completed daily or as necessary.

Grates and Open Burners: Brush burner head with a stiff wire brush. Clean clogged ports with stiff wire or ice pick. This procedure should be completed daily or as necessary.

OVENS

General: All ovens should be given a periodic general check up. Lint and grease suspended in the air tend to collect in passages. Therefore, all flues, burner parts, primary air openings, etc., should be periodically cleaned to prevent clogging.

The exterior should be washed with a mild soap and water solution daily, and dried with a clean cloth.

The interior should be cleaned daily. Remove racks. A scraper, wire brush or steel wool may be used on hard accumulations. Caution should be used when using abrasives on "self-cleaning" surfaces. Commercial oven cleaners can be used but special care should be given to thoroughly drying afterwards.

For seasonal shut-downs, clean as suggested above. Use a mineral oil on all interior surfaces. If possible, keep pilot light lit. Prior to starting after seasonal shut-down, wipe all clean surfaces with a clean cloth.

Range Ovens: Remove boil-overs and spill-overs daily before materials have time to harden or carbonize. Be sure oven exterior is cool before cleaning. Prop the door open slightly until chamber cools; moisture and odor will quickly disappear. Wipe oven bottom and lining with a damp (not wet) cloth. Brush off encrusted materials.

Never throw water on oven decks to cool them. In extreme cases a commercial oven cleaner may be applied to porcelainized areas only.

Convection Ovens: Wait until oven cools, then remove racks and guides and clean as mentioned above under "Range Ovens."

The fan and blower shield should be cleaned weekly by removing the back panel. Refer to your instruction manual for proper removal procedures. Fan motors do not require lubrication. Check for proper operation semi-annually.

Check door gaskets periodically for loss of heat due to the collapse of the gaskets. Replace if necessary.

Have the factory service agency check the controls and thermostats semi-annually for accurate temperature calibration.

Stack or Deck Ovens: Follow the same procedures outlined under "Range Ovens."

Microwave Oven: Clean all interior surfaces daily with a damp cloth and wipe dry. Clean all exterior surfaces with warm water and a mild detergent. Do not allow food particles to collect on interior surfaces and door.

Check the door seal and hinges for tightness. If there is any indication of a loose seal, shut unit down and contact the local service agency for repair. Do not operate the unit with an improper seal.

Remove air intake filter weekly and wash in hot water in the dishwasher.

Controls should be inspected semi-annually for calibration and accuracy by the proper service agency.

STEAM KETTLES

After use, kettles should be filled immediately with warm water and mild detergent and should be washed with a nylon kettle brush.

Tilting mechanism joints should be lubricated monthly. Valves should be checked semi-annually for possible leaks.

STEAM COOKERS

Remove all shelves and uprights and wash them in mild detergent and warm water daily. Clean interior and exterior daily with a mild detergent solution and warm water.

The fuel supply to the unit should be turned off at the end of each day's operation.

Check the door gasket weekly and replace when necessary. Lubricate the door hinges monthly. Leave doors open slightly when not in use.

Controls and valves should be checked semi-annually by a qualified service agency.

STEAM GENERATORS

Check the water level gauge frequently, but at least once a day. The proper water level must be maintained. The fuel supply to the unit should be turned off at the end of each day's operation.

Once or twice a week, drain boiler while it is at operating pressure in order to flush out any sediment which may have formed in the unit.

Major boiler cleaning should be done two or more times per year depending upon local water conditions and also prior to prolonged shutdown.

This cleaning procedure should be accomplished according to the manufacturer's step-by-step instructions.

Valves should be checked monthly for proper operation and possible leaks.

BROILERS

Empty grease drawer, scrape drip pan and grease hopper daily. Rods may be removed and left to soak over night in water to loosen material build-up.

Clean all exterior surfaces with warm water and detergent daily. Clean all interior surfaces of the broiling compartment thoroughly at least once a week. Use a long handled scraper and soft brush to loosen stubborn food particles.

Controls should be checked semi-annually by a qualified service agency.

FRYERS

Drain and filter fat daily. Clean the pot and heating elements with a stiff brush.

On electric fryers, lift the calrod or heating element to a partially raised position and allow it to drain thoroughly. Then lift the element to the fully raised position and turn on fryer. Let the elements heat for two minutes at 400° to allow them to burn clean. Brush carbon from the elements with a soft brush. Perform this operation weekly.

Controls and thermostats should be inspected semi-annually for calibration and accuracy by the proper service agency.

GRILLS

Scrape top with spatula or scraper to keep surface free of encrusted food during use. Wipe frequently with a heavy absorbent cloth. After griddle is cool, polish with griddle stone and mild detergent weekly. Turn down burners during slack periods, and do not overheat.

Controls and thermostats should be inspected semi-annually for calibration and accuracy by a qualified service agency.

GENERAL MAINTENANCE

INCINERATORS

The Environmental Protection Act requires that a permit to operate or install an incinerator be obtained from the Environmental Protection Agency. Application blanks and operational procedures may be obtained from:

The Environmental Protection Agency
Air Pollution Control
2200 Churchill Road
Springfield, Illinois 62706

VENTILATION

General: Wipe and clean all exposed surfaces daily to remove grease before it has a chance to harden on the surfaces.

The interior of the ventilator should be cleaned periodically depending on local codes, usage, and soil accumulation.

A good grade of non-toxic stainless steel polish should be applied to stainless steel surfaces to maintain and protect the original finish.

On ventilators with grease cups, daily inspection is required. Keep this cup empty and clean to prevent overflowing.

Wire Mesh Type Ventilator: Remove all filters from hood weekly, soak them in hot water and run them through the dishwashing machine. Let filters dry overnight before reinstalling them in the ventilator.

Clean all interior surfaces of the ventilator, particularly behind the filter bank before replacing the filters.

Baffle Type Ventilator: Remove baffles from hood, and clean by running them through the dishwasher, hand scrubbing in a pot sink or steam cleaning.

Since baffles are self-draining, the grease collection cap should be checked often and kept empty.

Clean interior surfaces behind baffles before replacing.

Detergent Wash Down Type Ventilator: Approximately every 300 hours of operation of the detergent pump, open the oil plug at the top of the motor and apply four drops of high temperature oil. Check the foot valve at this time to make sure that the suction screen is not clogged. The foot valve is located in the detergent tank on the end of the suction tube.

Detergent wash systems should be activated daily to keep all baffles free of grease. Check detergent tank weekly to insure that it has not run dry.

Fire Protection Systems: All extinguishers should be checked periodically depending on local code requirements. Check the local fire codes in your area.

REFRIGERATION

General: Check temperature of all thermometers daily. Cooler thermometer must indicate a temperature of 45° F. or less. Freezer thermometer should indicate a temperature of −10° F.

Walk-In Cooler/Freezers: Check the oil level in the compressors weekly and check the sight glass for color change. If there is a noticeable change, there is moisture in the refrigeration lines. Notify the local service agency if this occurs.

Every six to eight weeks clean dust and dirt off compressors and cooling coil.

General cleaning of walls and floors should take place weekly.

Reach-In Refrigerators/Freezers: The entire refrigerator interior and exterior should be cleaned thoroughly each week. If any spillage of foods occurs, that portion of the cabinet should always be cleaned immediately. Keep door gasket clean and free from grease. The gasket should be wiped clean with lukewarm water and mild soap once a week.

Motors are hermetically sealed with a lifetime oil supply. No lubrication is necessary.

The condenser radiator should be cleaned by brushing or vacuuming lint and dust away from unit semi-annually.

Ball bearing rollers on self-closing doors should be oiled monthly.

Check door gaskets monthly for leakage. Replace when necessary.

All refrigeration and electrical adjustments should be made by a qualified local service agency.

Ice Machines: The condensing unit blower coil should be cleaned of dirt and lint three or four times a year. Semi-annually complete the following procedures:

1) Clean evaporator, hot water tank, sump pump and screen.
2) Tighten all electrical connections.
3) Tighten all bolts.
4) Check water supply and pressure flow control.
5) Clean water strainer.
6) Oil drive motor at oil cup points.
7) Oil condenser fan motor if oil cups are provided.
8) Check for refrigerant and water leaks.
9) Tighten drain line connections.
10) Check bin thermostat setting for conformance to manufacturer's specifications.

If leaks have developed or major adjustments must be made, contact a qualified service agency.

GENERAL MAINTENANCE

Stainless Steel

The same basic procedures are used in cleaning stainless steel equipment, regardless of the equipment's function. With soft food, dirt and grease, the best procedure is to remove deposits from the surface as soon as possible to avoid having them baked on or dried on. Use soap, detergent, or ammonia and water. If deposits of this type are removed promptly and regularly, nothing more than cloth, fiber brush, or sponge will be needed in most cases.

When food and grease deposits are more stubborn, treat hard-to-clean areas with a cloth soaked in ammonia and water. Leaving the cloth in place for 10 to 15 minutes while other chores are done will usually make the deposits easy to remove.

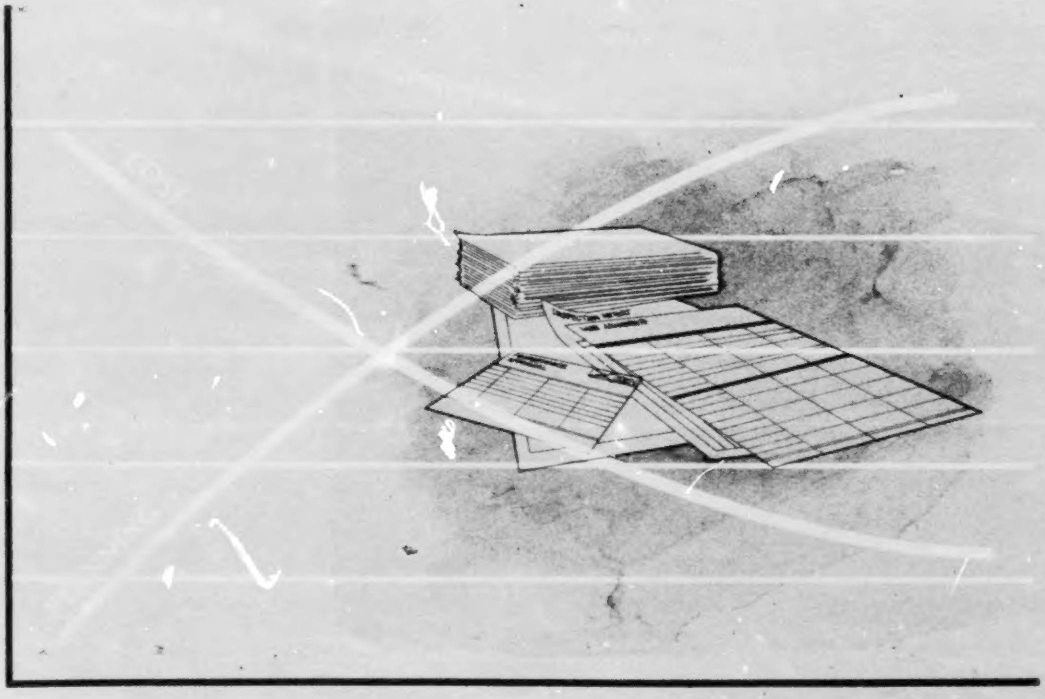
Stubborn, baked-on deposits can't always be avoided, and usually occur when spills burn on, or cleaning is neglected for a day. In such cases, when scouring becomes necessary, observe these guidelines: deposits will come off easier if rubbed in the same direction as the polish lines on the metal, and rubbing in this manner avoids the possibility of marring the appearance of the surface. Use as little pressure as necessary. Scrapers and cleaning instruments should be stainless steel, wood, plastic, or hard rubber, and only stainless steel wool should be used.

Common steel wool, wire brushes, files, or other non-stainless steel tools may leave particles of iron imbedded in the stainless steel surface, which may themselves rust and cause stains. An excellent cleaning paste for stainless surfaces may be made by adding magnesium oxide, finely powdered pumice or French chalk to a solution of ammonia and water. When using this or any other abrasive cleaner, use the finest grit capable of doing the job.

After scouring, always wash equipment with detergent, soap or ammonia and water. Also, be sure to remove all cleaning materials with a thorough rinse of clean potable water.

Summer Maintenance

It is recommended that all your food service equipment be annually serviced during the summer months. When school begins, all equipment will be ready to operate. A local qualified service agency should be able to solve all equipment problems in one or two service calls at a reasonable cost.



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CUSTODIAL AREA ASSIGNMENT

TO: ______________________ ______________ ______________

Building Time Allotted

General description of area to be serviced:

____

____

It is intended that each written assignment and the periodic cleaning schedule provide a full eight hours of work. If this assigned area fails to include enough work to keep busy, contact the person in charge immediately and the situation will be corrected. Periodic cleaning such as waxing furniture is not covered in this written assignment, but it is the responsibility of the custodian to see that all periodic cleaning is accomplished.

The assignment details the work and, under normal conditions, the time the work is to be performed. Supervision may find it necessary from time to time to adjust the assignment. If there are any questions, please discuss them with the person in charge.

As members of the custodial team, each individual is expected to do the best job he or she can. Your job will be easier when you enjoy and receive satisfaction from your work and have a friendly feeling for the people you meet and work with.

Supplies and equipment are in Rooms ______, ______, ______, ______, ______, ______.

	TASKS OR COMBINATION OF TASKS	HOURS From	To
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Miscellaneous:

a. Perform periodic cleaning.
b. Keep custodial areas, equipment and supplies neat, clean and orderly.
c. Remove ice and snow from entrances.
d. Report repairs needed.
e. Clean bulletin board glass and all inside glass in your area excluding exterior windows.
f. Turn out all unnecessary lights.

Date______ Approved ______________________

DAILY WORK REPORTS

DAILY PERIODIC AREA CLEANING REPORT

Building ____ Loc. No. ____ Date ____

Custodian ____ Hours ____

Area — Use	Type of Cleaning
L—Lab	PD—Periodic dusting
O—Office	CW—Clean-Wax
C—Classroom	G—Glass
R—Restroom	X—____
H—Hallway	O—____
	XX—____

Room Number or Area Description	Area Use	Type of Cleaning	Number of Items of Furniture							Other Information
			Chairs	Desks	Tables	Files	Bookcases			

DAY
NIGHT

FLOOR MAINTENANCE DAILY WORK REPORT

Building ____ Location ____ Date ____

Name ____ Hrs. ____ Name ____ Hrs. ____

Name ____ Hrs. ____ Name ____ Hrs. ____

Total Hours ____

AREA - USE		PROCEDURE	
L—Lab	R—Restroom	C—Clean	R—Renovate
O—Office	H—Hallway	W—2 Coats Wax	N—Numastic
C—Classrcom		SS—Safe-T-San	S—Strip
		T—Terrazzine	F—2 Coats Fin.
		D—Dura Seal	SE—Seal

Room No. or Area Descrip.	Area Use	Floor Type	Procedure Used	Sq. Ft.*	Other Info.

*Office Use Only

Continued

DAILY WORK REPORTS *continued*

Day______
E. Night______
D. Night______

CARPET AND UPHOLSTERY WORK REPORT

Building ______ Location ______ Date ______

Name ______ Hrs. ______ Name ______ Hrs. ______

Name ______ Hrs. ______ Name ______ Hrs. ______

Total Hours ______

AREA USE CODE

L—Lab
O—Office
C—Classroom
H—Hallway
ST—Stairs
R—Reception
E—Entrance
______ Other

PROCEDURE

PL—Pile Lift
SP—Spot Clean
DF—Dry Foam Shampoo
AS—Anti-Static Treatment
OC—Odor Control (Vomit, etc.)

CARPETING

Room No. or Area Description	Area Use	Carpet Type	Carpet Color	Procedures Used	Amount and Type of Cleaning Materials	Square Footage

COMMENTS ______

WINDOW WASHING DAILY WORK REPORT

Building ______ Location ______ Date ______

No. of Men ______ Total Hours ______

Total Hours to Remove Blinds . . . . ______
Total Hours to Clean Blinds . . . . . . ______
Total Hours to Install Blinds . . . . . . ______
Total Hours to Dust Blinds . . . . ______
Total Hours to Clean Windows . . . . ______
☐ **Outside and Inside**
☐ **Inside only**
Total Hours to Clean Screens . . . . . ______

Area Desc. or Room No.	Venetian Blinds				Glass Washed			Other Info.
	Removed	Washed	Installed	Dusted	Window	Storm Windows	Screens	

CUSTODIAL INSPECTION REPORT

FLOOR MAINTENANCE

Date ____________________

Crew Inspected

________________ Name ________________ Name ________________ Name

Building ________________ Location No. ________ Areas Inspected ________________

Floor Type ____________________ Floor Condition: ☐ Good ☐ Fair ☐ Poor

Condition of Finish: ☐ Good ☐ Fair ☐ Poor ☐ Bad

I. Procedure Used

- Dust mopping .... ☐
- Dry cleaning .... ☐
- Cleaning w/finish .... ☐
- Renovating .... ☐
- Water mopping .... ☐
- Machine scrub .... ☐
- Auto scrub .... ☐
- Water pick-up .... ☐
  - Mop & bucket .... ☐
  - Water vac .... ☐
- Rinsing .... ☐
- Seal: 1 coat .... ☐
  - 2 coats .... ☐
  - 3 coats .... ☐
  - Brand ____________
- Finish: 1 coat .... ☐
  - 2 coats .... ☐
  - 3 coats .... ☐
  - Brand ____________
- Cleaner Used:
  - Brand ____________

II. Equipment

	Condition		
	Clean		Needs Replacement
Dry mops	☐	☐	☐
Wet mops	☐	☐	☐
Mop Units	☐	☐	☐
Floor machine	☐	☐	☐
____________	☐	☐	☐

III. Work Evaluation 1—Unsatisfactory 2—Marginal 3—Average 4—Above average 5—Outstanding

Quality of Finished Floor —1—2—3—4—5

Streaking	☐ Yes	☐ No
Caused by	☐ Products	☐ Employees
Splash mark	☐ Yes	☐ No
Lap marks	☐ Yes	☐ No
Clean baseboards	☐ Yes	☐ No
Void spots	☐ Yes	☐ No
Built-up	☐ Yes	☐ No
Powdering	☐ Yes	☐ No

IV. Personnel Evaluation — Evaluate each crew member annually on the "Work Appraisal" Form.

V. Verbal Summary ____

____

____

I Approve - Disapprove This Evaluation ____________________ Supervisor

CUSTODIAL INSPECTION REPORT

WINDOW MAINTENANCE

____________________ Date

I. Crew Inspected ____ Name ____ Name ____ Name ____ Name

____ Name ____ Name ____ Name ____ Name

II. Building ____ Loc. No. ____ Areas Insp. ____

A. Window Washing (Condition of Windows: Heavy soil ☐ Avg. soil ☐ Light soil ☐)

1. Procedure Used

- Belts ☐
- Window pole ☐
- ____ ☐
- ____ ☐

2. Equipment

- Buckets ☐
- Sponges ☐
- Cheesecloth ☐
- Squeegee ☐
- ____ ☐
- ____ ☐

3. Supplies

Cleaner used:

- Ammonia ☐
- ____ ☐
- ____ ☐
- ____ ☐
- ____ ☐

4. Condition of Supplies and Equipment

	Adequate	Inadequate	Dirty	Clean	Needs Replacement
Equipment	☐	☐	☐	☐	☐
Supplies	☐	☐	☐	☐	☐
Belts	☐	☐	☐	☐	☐
Ladders	☐	☐	☐	☐	☐

B. Dusting (Condition of Venetian Blind: Heavy soil ☐ Avg. soil ☐ Light soil ☐)

1. Procedure Used

- Vacuuming ☐
- Washing ☐
- ____ ☐

2. Equipment

- Back vac. ☐
- Vacuum ☐
- Duster ☐

3. Supplies

- ____ ☐
- ____ ☐
- ____ ☐

4. Condition of Equipment and Supplies

	Adequate	Inadequate	Dirty	Clean	Needs Replacement
Vacuum	☐	☐	☐	☐	☐
____	☐	☐	☐	☐	☐
____	☐	☐	☐	☐	☐

III. Work Evaluation (1 - Unsatisfactory, 2 - Marginal, 3 - Average, 4 - Above Average, 5 - Outstanding)

1. Quality of Finished Work 1 - 2 - 3 - 4 - 5 (Circle one)

Streaky windows	☐ Yes	☐ No
Blind dusting	☐ Adequate	☐ Inadequate
____	☐ Accidents	☐ No accidents

2. Individual Evaluation—Evaluate each crew member annually on the "Work Appraisal" Form.

IV. Verbal Summary: ____

____

____

____

____

____ Inspector

I Approve - Disapprove This Evaluation. ____ Supervisor

CUSTODIAL AREA SANITATION REPORT

Building ________________________

________________________ Custodian Date ________________ 19______

KEY

DI—Dirty
DU—Dusty
S—Smeared or Stained
L—Littered

WX—Needs Wax
CW—Cobwebs
O—Organization
R—Repair Needed

WA—Needs Washing
SV—Service Needed
✓—Satisfactory

Item	Room No. or Area				
Mirrors					
Shelves					
Soap Dispensers					
Sinks					
Towel Cabinets					
Supplies					
Sanitary Cabinets					
Urinals					
Toilet Bowls					
Toilet Paper					
Tile/Marble					
Furniture					
Equipment					
Metal Partitions					
Waste Cans					
Floors					
Radiators					
Window Ledges					
Woodtrim					
Baseboards					
Rest Room Doors					

Item	Room No. or Area				
Door Glass					
Transoms					
Blackboards					
Chalktrays					
Erasers					
Tables					
Book Cases					
Desks					
Desk Lamps					
Ash Trays					
Telephones					
Chairs					
File Cabinets					
Smoking Urns					
Steps/Stairs					
Handrail					
Drinking Fountains					
Bulletin Boards					
Pipes/Ducts					

Use reverse side for any additional comments.

This Report Has Been Discussed With Me.

____
Custodian's Signature

(Over)

Building ______________________ Custodian

PROBATIONARY ☐

ADDITIONAL COMMENTS:

CERTIFIED ☐

UNACCEPTABLE ☐ BELOW AVERAGE ☐ AVERAGE ☐ ABOVE AVERAGE ☐ OUTSTANDING ☐

COMMENTS FROM CUSTODIAN:

WORK APPRAISAL FOR

☐ Annual
☐ Special
☐ **Probationary**
☐ 1st mo. ☐ 2nd mo. ☐ 3rd mo.
☐ 4th mo. ☐ Special ☐ Special

Name ______________________________
Classification ______________________________
Period from ______________ to ______________

I. Performance Appraisal (rate each item by selecting the phrase most closely describing the employee's actual work performance).

1. **Job Knowledge**
   a. Area work
   ______ Needs more training and experience
   ______ Able to perform most of the work
   ______ Knows enough to get by
   ______ Able to perform all work well
   ______ Able to perform most of the routine work
   ______ No experience in past year

   b. Floor work
   ______ Able to perform most of the routine work
   ______ Needs more training and experience
   ______ Able to perform all work well
   ______ Able to perform most of the work
   ______ Knows enough to get by
   ______ No experience in past year

   c. Public function setups
   Moving
   Window washing
   ______ Able to perform all work well
   ______ Able to perform most of the routine work
   ______ Able to perform most of the work
   ______ Needs more training and experience
   ______ Knows enough to get by
   ______ No experience in past year

2. **Ability to Improve**
   ______ Has mastered all duties of the position and still has the capacity to do more
   ______ Unable to do most of the routine work
   ______ Lacks ability to perform the work required by this position
   ______ Has mastered most of the duties and still has the capacity to do more
   ______ The routine work is the best that can be done and it causes trouble sometimes
   ______ ______________________________

3. **Quantity of Work**
   ______ Has difficulty in organizing time in order to produce acceptable quantity of work. Has to be told what to do most of the time
   ______ Self-starter—makes above average use of work time
   ______ Needs prodding or work time will be unproductive
   ______ Makes average use of work time and achieves average quantity of work
   ______ Self-starter—makes outstanding use of work time
   ______ ______________________________
   ______ ______________________________

4. **Quality of Work**
   ______ Work is outstanding, rarely find items that need improvement
   ______ Work is above average, rarely find examples that have been skipped or neglected
   ______ Quality of daily and periodic work is average
   ______ Weekly checks are necessary
   ______ Daily checks are necessary
   ______ ______________________________
   ______ ______________________________

5. **Attitude Toward Work**
   ______ Appreciates help and criticism
   ______ Downgrades the school and many of the employees
   ______ Does what is expected
   ______ Respects the school and his position in organization
   ______ Just another job—makes caustic remarks
   ______ ______________________________
   ______ ______________________________

6. **Initiative**
   ______ Little evidence of initiative noticed during working hours
   ______ Develops solutions to problems
   ______ No indication of initiative during working hours
   ______ Develops workable solutions to most problems on his own but keeps supervision informed
   ______ Relies on others but follows suggestions
   ______ ______________________________

7. **Loyalty**
   ______ Critical of the school
   ______ Willing to talk about the school in a positive way
   ______ Inclined to be one-sided and negative about the school
   ______ Self-starter, always willing to explain the school in a positive way
   ______ If others insist, he will talk about the school in positive terms
   ______ ______________________________
   ______ ______________________________

8. **Personality**
   ______ Talker but seems to get along with others
   ______ Quiet but gets along with others
   ______ Gets along with others
   ______ Creates some feelings against self
   ______ Respected by others
   ______ ______________________________

9. **Dependability**
   ______ Average in work production and average attendance record
   ______ Above average in work production with a perfect attendance record
   ______ Average in work production with an unexplained attendance record average of one day sick every two months
   ______ Barely average in work production with an above average attendance record

(over)

______ Above average in work production with an above average attendance record
______ ______________________________
______ ______________________________

10. Accident Prevention

______ Talks a lot about safety but doesn't do much about it
______ Takes chances
______ Works safely most of the time
______ Sets a good example in safe work habits and encourages others to do the same
______ Doesn't take chances but shows little interest in accident prevention
______ ______________________________
______ ______________________________

11. Physical Makeup

______ Complains that work is too hard and the job is too large
______ Accomplishes work with energy to spare
______ Accomplishes work
______ Appears tired most of the time
______ Accomplishes work easily
______ ______________________________
______ ______________________________

12. Cooperation

______ He is argumentative
______ He is an outstanding team worker
______ He always does what is asked of him
______ He seldom voices objections
______ He always does a little more than is asked of him
______ ______________________________
______ ______________________________

II. General Comments

Comments on outside (second) job ______________________________
Shift preference ______________________________
Health ______________________________
Attendance ______________________________
Progress ______________________________
Suggestions for self-improvement or development ______________________________
____
Other comments ______________________________
____

______________________________ (Date)

______________________________ Signature of person making work appraisal

III. Comments or suggestions by shift supervisor ______________________________
____
____
____

IV. Comments or suggestions by other members of office supervision ______________________________
____
____
____

This work appraisal has been discussed with me

______________________________ (Signature of employee)

______________________________ (Date)

______________________________ (Signature of person explaining work appraisal)

ASPHALT SURFACES RECORD

AREA LOCATION	AREA SIZE	TOTAL SQ. FT.	COMPOSITION OF SURFACE	SCHEDULE CATEGORY				SCHEDULE				REMARKS
				I	II	III		CRACK FILL	SEAL COAT	PATCH	SUR-FACE	

BURNER INFORMATION RECORD

MAKE ______________ MODEL ______________ SERIAL # ______________

GAS BURNER

CO$_2$

High Fire ______________

Low Fire ______________

CO

High Fire ______________

Low Fire ______________

Net Stack Temperature

High Fire ______________

Low Fire ______________

Gas Burning Rate

High Fire ______________

Low Fire ______________

Gas Pressure at Orifices

High Fire ______________

Low Fire ______________

Gas Pressure Upstream of all Valves

High Fire ______________

Low Fire ______________

OIL BURNER, Grade ______________

CO$_2$

High Fire ______________

Low Fire ______________

Smoke Bachrach Scale

High Fire ______________

Low Fire ______________

Nozzle Pressure

High Fire ______________

Low Fire ______________

Oil Burning Rate

High Fire ______________

Low Fire ______________

Net Stack Temperature

High Fire ______________

Low Fire ______________

Maintenance Checklist for

ROOFTOP AIR CONDITIONING

Date ______________________

Unit Model ______________________

Unit Serial ______________________

(X) Indicates when checks are made
(/) Indicates service performed

MAINTENANCE CHECKS	Weekly	Monthly	Yearly	Comments and Readings
I. ROOM THERMOSTATS				
A. Check to make sure they respond properly	X			
II. SUPPLY FANS				
A. Listen for bearing noise	X			
B. Grease bearings			X	
C. Check fan belt tension		X		
D. Replace fan belts			X	
E. Check fan sheaves			X	
F. Check for debris in fan inlet		X		
III. RETURN FANS				
A. Listen for bearing noise	X			
B. Grease bearings			X	
C. Check fan belt tension		X		
D. Replace fan belts			X	
E. Check fan sheaves			X	
F. Check for debris in fan inlet		X		
IV. CONDENSER FANS				
A. Listen for bearing noise	X			
B. Grease bearings			X	
C. Check fan belt tension		X		
D. Replace fan belts			X	
E. Check fan sheaves			X	
F. Check for debris in fan inlet		X		

(over)

ROOFTOP AIR CONDITIONING CHECKLIST *continued*

MAINTENANCE CHECKS	Weekly	Monthly	Yearly	Comments and Readings
V. COOLING COIL				
A. Check filters and replace as required	X	X		
B. Clean coil			X	
C. Refrigerant sight glass clear	X			
D. Drain in pan free		X		
VI. CONDENSER COIL				
A. Fan guards in place	X			
B. Clean coil		X		
C. Check and repair fins		X		
VII. REFRIGERANT COMPRESSOR				
A. Check oil level in sight glass	X			
B. Suction line cool to touch	X			
C. Check for short cycling	X			
D. Check for obvious leaks		X		
E. Check control panel wiring and contactors		X		
F. Install refrigerant gauges and check the following:				
1. Suction pressure			X	
2. Discharge pressure			X	
3. Voltage			X	
4. Amperage			X	
VIII. HEATING SECTION				
A. Check flue vents			X	
B. Check burner compartment for flame leakage	X			
C. Listen to burner light off	X			
D. Listen to burner operation	X			
E. Check electrical control panel on electrical heating units		X		
IX. MISCELLANEOUS				
A. Check all damper linkages and lubricate			X	
B. Check all panel door gaskets and caulk panel seams			X	
C. Check insulation on interior panels and repair as necessary			X	

Maintenance Checklist for

PNEUMATIC TEMPERATURE CONTROLS

AIR COMPRESSORS & ACCESSORIES (✓)
Drain and inspect tank .... ______
Drain and refill crankcase oil .... ______
Oil electric motor .... ______
Clean and/or replace air intake filter .... ______
Inspect tank valve stem packing .... ______
Check belt tension. Replace worn belt .... ______
Examine motor brushes and commutator .... ______
Inspect and/or replace pressure switch contacts .... ______
Check pressure relief valve operation .... ______
Check pressure reducing valve setting .... ______
Check air lines for moisture, oil and dirt .... ______
Check sediment and water trap .... ______

THERMOSTATS
Check calibration .... ______
Check throttling range .... ______
Check air connections .... ______
Adjust system sequence .... ______

HYGROSTATS
Check calibration .... ______
Check throttling range .... ______
Clean or replace element .... ______
Check air connections .... ______
Adjust system sequence .... ______

DAMPERS AND DAMPER MOTORS
Check travel and close off .... ______
Lubricate blade and linkage bearings .... ______
Check motor connections and spring .... ______
Check air connections .... ______
Adjust system sequence .... ______

VALVES (✓)
Check operation for tight close off .... ______
Lubricate valve stem .... ______
Inspect and/or replace packing .... ______
Replace disc where necessary .... ______
Check air connection .... ______
Adjust system sequence .... ______

PRESSURE REGULATORS
Check calibration .... ______
Check throttling range .... ______
Check pressure setting .... ______
Adjust system sequence .... ______

RELAYS, PILOT VALVES, SWITCHES
Check operation .... ______
Adjust system sequence .... ______

THERMOMETERS
Check calibration .... ______

OTHER: ______________________________
____
____

COMMENTS: ______________________________
____
____

Annual Inspection

Guidelines and Checklists

In addition to the routine maintenance programs described throughout this manual, the authors recommend a special annual inspection of all buildings and equipment. Such an inspection can be invaluable in evaluating the effectiveness of the school maintenance program and in planning and budgeting for the next year's maintenance effort.

The annual inspection suggested here is not designed to replace routine maintenance nor to supersede programs described throughout the manual.

Five separate inspection check lists are provided on the following pages. They cover the major items which must be included during the annual inspection of:

- Buildings — Exterior and Interior
- Plumbing
- Heating and Ventilating Systems
- Electrical Systems
- Fire Protection Equipment

In using these check lists for annual inspections, it is recommended that:

1) **The check lists** should serve as a starting point for developing the school district's own check lists. Lists provided here may not cover all equipment found in a school. Each school may have its own peculiar conditions.

2) **Inspection lists** should be printed and used by the inspector as guides in surveying building structures and equipment.

3) **The annual inspection** should be made in the early spring, allowing time to plan and perform all repairs during summer vacation.

4) **The inspector should** operate all equipment, such as doors, windows, faucets, flush valves, ventilators, and switches. He should look for leaking valves and faucets, items which have been improperly cleaned, and similar flaws.

5) **The inspector should** make written note of any items missing, broken, or defective. If possible, he should estimate the cost of repair (this may be added later).

6) **Sufficient time** should be allowed to make the inspection a thorough one.

ANNUAL BUILDING INSPECTION CHECKLIST

School ______________________________

Inspector ____________________________

Date ________________________________

EXTERIOR MAINTENANCE	REMARKS	COST EST.
1. Roof		
Cracks		
Blisters (vapor)		
Wrinkles		
Ponding		
Gravel blown off		
Wet insulation		
Dry felts		
Foreign objects on roof		
2. Flashings & Counterflashings		
Composition flashings		
Cracks		
Open joints or end laps		
Pulled away from wall		
Metal counterflashings		
Pulled out of reglets		
Loose wedges		
Deteriorated caulking		
Rusted galvanized iron		
General deterioration		
Expansion joints		
Cracks		
Mislocated or loose blocking		
Deteriorated elastic membrane		

Building Inspection second page	**REMARKS**	**COST EST.**
2. Flashings & Counterflashings—continued		
Gravel stops and gutters		
Peeling paint		
Broken solder joints		
Separated from roof piles		
3. Skylights		
Secured to supports		
Cracks, etc.		
4. Plumbing Vents		
Vandalism		
5. Antennas, Signs, Etc.		
Rust and peeling paint		
Loose guys		
Roof seal		
6.. Parapets		
Open mortar joints		
Open joints in copings		
7. Chimneys		
Deteriorated brick, joints		
Flue liner		
Flashing		
8. Walls		
Cracks		
Paint condition		
Moisture (efflourescence, etc.)		
Areaways		
Caulking		
Windows (paint, etc.)		

Building Inspection third page	**REMARKS**	**COST EST.**
8. Walls—continued		
Doors		
Closers		
Exit devices		
Locks and misc. hardware		

INTERIOR MAINTENANCE

1. Structural System

Rot, splitting, rust		
Termites		
Deflection		
Cracks		

2. Stairs and Handrails

Loose handrails (anchorage)		
Worn treads		
Paint or varnish, etc.		

3. Interior Walls

Cracks, bulges, etc.		
Paint conditions		
Dirt		

Building Inspection fourth page	**REMARKS**	**COST EST.**
4. Ceilings		
Cracks, bulges, etc.		
Paint condition		
Dirt		
5. Floors		
Wood		
Deteriorated areas		
Finish condition		
Resilient floor coverings		
Damaged areas		
Finish condition		
Carpet		
Stains		
Dirt		
Base		
Stains		
Dirt		
Paint condition		
6. Doors		
Closers		
Exit devices		
Hinges		
Locks and Latchsets		
Keying		
Misc. door hardware		

Building Inspection fifth page	REMARKS	COST EST.
7. Windows		
Putty and caulking		
Broken and cracked glass		
Sash operation		
Hardware		
Decay and termites		
Sills and stools, paint, etc.		
8. Shades and Blinds		
Hardware		
Blades (dirty or paint cond.)		
Fabric		
Rollers		

BUILT-IN EQUIPMENT

1. Lockers		
Hardware		
Numbering		
Paint condition		
Doors (warped or damaged)		
2. Stage Equipment		
Curtains and backdrops		
Track, hardware, etc.		
Rigging, counter weights, etc.		
Dimmer equipment (by electrician)		
Lubricate as required		
Lighting (bulb, etc.)		
3. Auditorium Seating		
Anchorage		
Dirt		
Damage to fabric, missing parts		

Building Inspection sixth page	**REMARKS**	**COST EST.**
4. Auditorium and Gym Exits		
Exit lights		
Exit devices		
Emergency lighting		
5. Gymnasium Equipment		
Bleachers		
Damaged boards		
Lubricate as required		
Hardware		
Backstops and bankboards		
Paint condition		
Loose bolts and hardware		
Motorized equipment--check and lube		
Check cables, pulleys, etc.		

ANNUAL PLUMBING INSPECTION CHECKLIST

School ______________________

Inspector ______________________

Date ______________________

EXTERIOR	**REMARKS**	**COST EST.**
1. Storm Drainage		
Catch basin		
Broken or missing grate		
Filled with rubbish		
Drain pipe		
Clogged		
Broken		
Areaways		
Filled with rubbish		
Broken drain		
Ground hydrants		
Sill cocks		
Downspouts		
Water valve boxes		
Gas piping		
Grease interceptor		
2.		

INTERIOR

1. Corridor		
Cleanouts		
Drinking fountains		
Electrical water coolers		

Plumbing Inspection second page	REMARKS	COST EST.
2. Toilet Room		
Water closet		
Water closet seats		
Water closet valves		
Water closet tanks		
Lavatory		
Faucet		
Drain		
Urinal		
Valve		
Tank		
Drain		
Soap		
Dispensers		
Tank		
Floor drain		
3. Kitchen		
Sink		
Faucet		
Drain		
Disposer		
Gas valves (check pilots if shut off)		
Range		
Dishwasher		

Plumbing Inspection third page	**REMARKS**	**COST EST.**
3. Kitchen—continued		
Booster heater		
Gas pilot		
Temperature (190°F.)		
Flue venting		
Faucets		
Floor Drains		
4. Home Economics		
Gas valves & pilots		
Sink		
Faucet		
Drain		
Disposer		
Washer		
Faucet		
Drain		
5. Science		
Gas		
Air		
Sinks		
Faucets		
Drains		

Plumbing Inspection fourth page	**REMARKS**	**COST EST.**
6. Shop		
Gas		
Air		
Gasoline and oil interceptor		
Drains		
7. Elevator		
Drain		
Sump pump		
8. Equipment Rooms		
Drain from cooling units		
Valves		
Drains		
Sump pumps		
Sewage ejectors		
Water heaters		
Circulating pumps		
Thermometers		
Water meter		
Gas piping		
9. Roof		
Drains and downspouts		

ANNUAL HEATING AND VENTILATING SYSTEMS INSPECTION CHECKLIST

School ______________________________

Inspector ______________________________

Date ______________________________

EXTERIOR

The inspection of the exterior heating system consists of carefully noting the location and condition of the scheduled items.

Items to look for are:

1) Vandalism.
2) Badly rusted equipment and supporting devices requiring complete cleaning, priming and painting.
3) Masonry (chimneys) that is missing or masonry requiring tuck pointing of joints. Also masonry that is badly deteriorated by weathering or other action.
4) Damaged oil filling stations — including pipe and fittings.
5) Damaged vent piping and fittings.
6) Equipment and/or supporting devices so badly rusted or broken requiring replacement of parts.
7) Oil tank corrosion.
8) Bent and otherwise damaged louvers, bird screens, exterior dampers, ventilation equipment intake or exhaust ducts.
9) Inoperable exterior dampers.
10) Roof or wall type fan operation:
    (a) Fan running;
    (b) Damper operating.
11) Relief dampers or relief vents condition.
12) Roof flashing condition at:
    (a) Roof fan units;
    (b) Duct openings;
    (c) Pipe openings.
13) Chimney condition including supports.
14) Chimney weather cap conditions.

EXTERIOR	REMARKS	COST EST.
1. Chimney & Gas Vents		
Masonry		
Metal		
Cap		
Roof flashing		
2. Roof Fan		
Fan operable		
Damper		
Roof flashing		
Bird or insect screen		
General condition		

Heating and Ventilating Inspection second page	REMARKS	COST EST.
3. Roof Relief Openings		
Roof flashing		
Damper		
General condition		
4. Duct Intake or Exhaust		
General condition		
Roof flashing		
Bird or insect screen		
External damper		
Louvers		
5. Oil Tank		
General condition		
Sludge		
Fill piping		
Vent piping		
6. Gas		
Pipe condition		
Valves		
Vent pipe		
7. Wall Fan		
General condition		
Fan running		
Damper		
Flashing		
Bird or insect screen		
8. Unit Ventilator		
Exterior louver		

Heating and Ventilating Inspection third page

INTERIOR

The inspection of the interior heating system consists of carefully noting the location and condition of the scheduled items. Special note should be taken of noisy operation, leaks, excessive dirt accumulation, non-uniform temperatures, bearing failure.

Items to look for are:

1) Vandalism.
2) Inoperative equipment.
3) Damaged equipment.
4) Missing equipment.
5) Excessive noise.
6) Excessive vibration.
7) Excessive dirt, rust or scale.

Where equipment has movable parts, they should be operated. Burners and stokers should be operated and all operating and safety controls checked for proper working condition. Pumps, fans, heating units, heating and ventilating units, etc., should all be operated by means of their normal control devices.

Controls should be checked by competent mechanics on a twice-a-year basis. Maintenance contracts with a control manufacturer are desirable. Electrical and gas apparatus should be continually checked for deterioration, leaks, etc.

Indicate the condition of the various items, location, or other identification, type of service, repair or replacement needed, estimated cost if possible.

INTERIOR	REMARKS	COST EST.
1. Boiler		
General condition		
Smoke vent and/or breeching		
Draft control damper		
Insulation		
Relief valves		
Boiler tubes		
Burner or stoker		
Controls		
Boiler feeder		
Water glass		
Combustion air intake		
Blow-down		
Water treatment		
2. Pumps		
Boiler feed pump		
General condition		
Motor		
Valves		
Tank		
Insulation		
Controls		
Pressure valve		

Heating and Ventilating Inspection fourth page	REMARKS	COST EST.
Condensate pump		
General condition		
Motor		
Valves		
Receiver		
Controls		
Circulating water pump		
General condition		
Motor		
Valves		
Controls		
3. Expansion Tank		
General condition		
Site glass		
Water level		
4. Valves		
Leaking		
Packing		
Ease of operation		
5. Traps		
Float		
Seat		
Orifices		
6. Convectors and/or Baseboard Radiation		
General condition		
Coils, dirty		
Valves		
Trap		

Heating and Ventilating Inspection fifth page **REMARKS** **COST EST.**

7. Forced Flow Convectors or
   Fan-Coil Units

General condition		
Coils		
Controls		
Valves		
Motor		
Belt		
Bearings		
Trap		
Fan		

8. Unit Ventilator
   (Steam, Water or Gas)

General condition		
Coils, dirty		
Filter, dirty		
Motor		
Belt		
Bearings		
Fan		
Trap		
Dampers		
Controls		
Valves		
Outside air intake		
Combustion air intake		
Burner		
Gas valves & regulator		
Pilot and heat exchanger		
Vent and flashing		

9. Unit Heater
   (Steam, Water or Gas)

General condition		
Coil, dirty		

Heating and Ventilating Inspection Sixth page	REMARKS	COST EST.
9. Unit Heater—continued		
Motor		
Fan		
Bearings		
Valves		
Trap		
Burner		
Controls		
Belts		
Draft inducer		
Gas valve & regulator		
Pilot		
Burner and heat exchanger		
Gas vent and flashing		
10. Furnace		
General condition		
Filter, dirty		
Motor		
Belt		
Bearing		
Dampers		
Burner		
Controls		
Fan		
Gas valve & regulators		
Gas vent and flashing		
Outside air intake		
Combustion air intake		
11. Ventilating Units		
General condition		
Filter, dirty		
Motor		

Heading and Ventilating Inspection seventh page	**REMARKS**	**COST EST.**
11. Ventilating Units—continued		
Belt		
Fan		
Bearings		
Trap		
Valves		
Dampers		
Controls		
Burner		
Coils dirty		
Outside air intake		
Roof flashing		
Gas valve & regulators		
Pilot		
Burner and heat exchanger		
Gas vent and flashing		
Combustion air intake		
12. Control System		
General condition		
Compressor		
Air filter — dryer		
Thermostats		
Valves & valve operators		
Summer-winter change-over switch		
Tubing or wiring condition		

ANNUAL ELECTRICAL SYSTEMS INSPECTION CHECKLIST

School ______________________

Inspector ______________________

Date ______________________

ELECTRICAL SYSTEMS	REMARKS	COST EST.
1. Main Service		
Inadequate capacity		
Insufficient grounding		
Obsolete wiring insulation		
Obsolete entrance equipment		
2. Distribution System		
Overloaded branch circuits		
Obsolete wiring insulation		
Insufficient receptacles		
Oversize fuses		
Excessive extension cords		
3. Lighting		
Insufficient light intensity		
Broken fixtures		
Lamp replacement		
Need for outdoor lighting		
Emergency lighting needed		
4. Special Outlets Needed for:		
Shop equipment		
Kitchen equipment		
Laboratory equipment		
Home Ec. equipment		
Arts and crafts		

Electrical Systems Inspection second page	**REMARKS**	**COST EST.**
5. Fire Alarm System		
Does not conform to School Code		
Needs maintenance		
Faulty break-glass stations		
6. Exit Signs		
Inadequate number of signs		
Need maintenance		
Lamp replacement		
7. Clock and Program System		
Inadequate number of clocks		
Inadequate program bells		
Needs maintenance		
8. Other Systems Needing Attention		
Intercommunication		
Public address		
Television		
Scoreboard		

ANNUAL FIRE PROTECTION EQUIPMENT INSPECTION CHECKLIST

School ______________________

Inspector ______________________

Date ______________________

FIRE PROTECTION EQUIPMENT	**REMARKS**	**COST EST.**
1. Sprinkler Systems		
Valves		
Must be O.S. & Y. type		
Must be open		
Corrosion repairs		
Flow alarms		
Required for system with 5 or more sprinkler heads. UL approved		
Must activate building fire alarm system		
Dry pipe systems		
Check for proper air pressure in system		
Check low air pressure alarm system. Should actuate fire alarm system trouble signal		
Pressure or storage tanks		
Check for proper pressure		
Check for proper water level		
Check low pressure or low water alarm system. Should actuate fire alarm system trouble signal		
Distribution piping & sprinkler heads		
Check for leaks & corrosion		
Check for adequate hangers		

Fire Protection Equipment Inspection second page	**REMARKS**	**COST EST.**
2. Standpipe & Hose Equipment		
Hose & hose rack or cabinet		
Is hose properly stored & readily accessible?		
Is hose attached to standpipe with nozzle open & ready for use?		
Is hose serviceable without leaks, decay, etc.?		
3. Fire Extinguishers		
Check hose, nozzle, gaskets & examine for deterioration.		
Check for injuries due to misuse		
Test pump action type to see if pump functions		
Test continuous-stream type by pumping up pressure and ejecting vaporizing liquid in both up-and-down and around-the-clock positions		
Test stored-pressure and CO_2 by discharging small amount of liquid or foam to atmosphere		

GENERAL COMMENTS:

Soda-acid and chemical-foam type extinguishers should be examined several times each year to see that they have not been tampered with, are not empty, have not been removed from their designated places.

Cartridge-operated type extinguishers should be inspected to see that the water level is up to the proper mark. Cartridges should be removed, examined and weighed. If there is a weight loss of ½ ounce or more for cartridges, they should be discarded. Other inspection procedures should be the same as for soda-acid extinguishers.

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Service Associate Members 1976

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Heating and air pollution equipment

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School buses

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Architect

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Architects

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